NATURE

No. 4430 SATURDAY, SEPTEMBER 25, 1954 Vol. 174

CONTENTS

	Page
The Oppenheimer Case	569
Sir William Petty : a Genius of the Seventeenth Century. By Dr. A. R. Hall	573
Minerals used in Industry. By V. A. Eyles	574
The First Colonization of Britain by Farmers. By Prof. V. Gordon Childe, F.B.A.	575
Physiological Aspects of the Heating and Ventilation of Houses in Britain	577
Ahmedabad Textile Industry's Research Association. By Dr. Vikram A. Sarabhai	578
Abnormal Properties of Histones from Malignant Cells. By H. J. Cruft, Dr. C. M. Mauritzen and Dr. E. Stedman, F.R.S.	580
Obituaries :	
Dr. H. A. Lafferty. By Prof. R. McKay	585
Dr. W. E. Foster	586
News and Views	586
The Bulgarian Academy of Sciences. By Dr. D. R. Newth	590
Institute of Chemistry of Ireland : Summer School in Organic Chemistry. By Eva M. Philbin	590
Physics in Israel. By S. Weintroub	591
Ontario Research Foundation : Report for 1953	592
British Electrical and Allied Industries Research Association : Annual Report for 1953	592
Pyrophosphatases in Plants during Growth. By Dr. B. Naganna and C. E. Sripathi	593
Atomic Weights of the Monoisotopic Elements. By Prof. Henry E. Duckworth	595
Why Use Inbred Lines? By Dr. J. D. Biggers and P. J. Claringbold	596
Letters to the Editors :	
Psalliotin, the Antibiotic of *Psalliota xanthoderma*.—Nancy Atkinson, O.B.E.	598
Antibiotic Production by Actinomycetes in Soil demonstrated by Morphological Changes induced in *Helminthosporium sativum*.—I. L. Stevenson	598
Isolation and Characterization of Biosynthetic Arylsulphates.—Dr. K. S. Dodgson, F. A. Rose and Dr. B. Spencer	599
Effect of Temperature on the Inactivation of Phage labelled with Phosphorus-32.—C. Castagnoli and F. Graziosi	599
A Constituent of Male Sperm Antagglutin related to Vitamin E.—Prof. P. E. Lindahl and J. E. Kihlström	600
A Comparison of some Natural and Synthetic Melanins.—W. D. Stein	601
Ketose Oligosaccharides in the Apricot Fruit.—A. S. F. Ash and T. M. Reynolds	602
Occurrence of Fatty Acids with Uneven-numbered Carbon Atoms in Natural Fats.—Dr. F. B. Shorland	603
Basic Amino-acids of Silk Fibroin.—M. C. Corfield, F. O. Howitt and A. Robson	603
Olefinic Nature of Anacardic Acid from Indian Cashew-nut Shell Liquid.—V. J. Paul and Prof. Lourdu M. Yeddanapalli	604
Bacterial Soft Rot of Avocado Fruit.—Dr. Zafrira Volcani	604
'Browning' Reactions in Freeze-dried Extractives from the Skeletal Muscle of Codling (*Gadus callarias*).—Dr. N. R. Jones	605
Uptake of Phosphorus-32 by Mycorrhizal Plants.—T. M. Morrison	606
Antagonist Inhibition as the Earliest Sign of a Sensory-Motor Reaction.—H.-J. Hufschmidt and Tamara Hufschmidt	607
A Simplified Method for spreading the Chromosomes in the Rabbit Blastocyst.—Ole Venge	608
Breeding Season of the Wild Rabbit in New Zealand.—I. S. Watson	608
Environmental Control of Coat Changes in Cattle.—N. T. M. Yeates	609
Production of Worm-free Lambs at Pasture.—C. R. W. Spedding	611
Normal Hæmatological Values in the Buffalo.—Dr. E. S. E. Hafez and A. Anwar	611
In vitro Production of Tropical Black Earth.—Dr. D. G. Hessayon and R. G. Hutton	612
Pile Irradiation of Polyethylene Terephthalate ('Terylene').—Miss Audrey Todd	613
A Corrected Guldberg Rule.—Dr. S. T. Bowden	613
Paramagnetic Resonance, a New Property of Coal-like Materials.—J. Uebersfeld, A. Etienne and J. Combrisson	614
Electroretinal Photopic Sensitivity Curves.—Dr. E. P. Johnson and T. N. Cornsweet	614
A Disease Epidemic in Fish.—H. Affleck	615
Recent Scientific and Technical Books	Supp. viii

THE OPPENHEIMER CASE

THE decision of the Atomic Energy Commission by a vote of four to one, as announced on June 29, that Dr. J. R. Oppenheimer should be denied access to restricted data because, on the record before the Commission, he was not entitled to the continued confidence of the Government and of the Commission "because of the proof of fundamental defects in his 'character' " is, of course, a matter of domestic policy within the United States. Even had, however, Great Britain and the United States not been somewhat "mixed up" (Sir Winston Churchill's phrase) in the early development of the atom bomb, the termination in this manner of the Government career of one who had rendered such outstanding services in this field could not but be a matter of profound interest, if not concern, to scientific circles in Britain. His services could scarcely be utilized, for example, by the European Organization for Nuclear Research or the new international agency to promote the use of atomic energy for peaceful purposes without some embarrassment or at least raising some awkward questions for the United States. Moreover, as the B.B.C. Reith Lecturer of 1953, Dr. Oppenheimer's name and achievements in science have been brought before millions with whom they might otherwise have been unfamiliar. The last of the lectures was delivered several weeks before Dr. Oppenheimer was notified, on December 23, that his security clearance had been suspended. Nevertheless, the shock to public opinion generally is sufficiently great for a clear understanding of what has really taken place and what is implied in the decision to be matters of public importance as well as of scientific interest.

On the scientific side there are other important aspects. It has been generally known in Britain that before the Atomic Energy Commission announced its decision, and while the Personnel Security Board, appointed by the Commission, under the chairmanship of Mr. Gordon Gray, was conducting its hearing, numerous leading American scientists had affirmed their faith in Dr. Oppenheimer, and Dr. Du Bridge and Mr. Gordon Dean, a former chairman of the Atomic Energy Commission, had made statements in his support. The Executive Committee of the Federation of American Scientists and a number of physicists at the University of Illinois, many of whom had been closely associated with Dr. Oppenheimer, had testified to his loyalty and expressed concern at his suspension. Moreover, the recommendation of the Personnel Security Board that it would not be clearly consistent with the security interests of the United States to reinstate Dr. Oppenheimer's clearance rested on the opinion of the chairman, Mr. Gordon Gray, and one member of the Board, Mr. T. A. Morgan, and was opposed by Dr. W. V. Evans, the sole scientist on the Board, who recommended that Dr. Oppenheimer's clearance be reinstated. Further, the dissentient from the Atomic Energy Commission's decision was also a scientist, Dr. H. D. Smyth, well known as the author of the Smyth Report of 1945.

In such circumstances some attempt to appraise the situation impartially is essential, if only to avoid misunderstanding or recriminations between partners in what was once a joint enterprise and which may in the future become increasingly one again. This is the more essential in that the circumstances in which the inquiry into Dr. Oppenheimer's loyalty was reopened are such as to confuse the real issues—issues which are of importance to scientists everywhere, and not simply for those concerned with nuclear physics or the development of atomic energy in the United States. Fortunately, they have been well stated, independently of the Oppenheimer case, by American writers themselves such as Prof. W. Gellhorn, Prof. H. S. Commager, and recently by N. D. K. Price in his "Government and Science".

The Personnel Security Board itself was obviously aware of the importance of having some such yardstick by which to reach its decision after hearing about forty witnesses, including Dr. Oppenheimer, and examining some three thousand pages of testimony. In the twenty-three pages of its own findings and recommendations it attempts to set forth frankly some of these major issues and questions which it recognizes as possibly even more important than the outcome of the inquiry itself. Moreover, both the concurring and the dissenting opinions of the Atomic Energy Commissioners indicate a certain confusion of thought and clash of opinion over the ideas of loyalty and activity and the extent to which they can be fostered in a free community and the means by which it is possible to do so.

First, however, it should be said that the texts of the principal documents and letters of the Personnel Security Board, the Atomic Energy Commission and its general manager now published leave no doubt as to the fairness and thoroughness of the inquiry. To this, Mr. L. K. Garrison, Dr. Oppenheimer's attorney, pays generous testimony. Some of the assumptions made by Mr. Gray and his colleagues in reaching their findings may be naïve and their soundness is questionable; but there can be no question that they have carried out, with outstanding patience, consideration and integrity, a difficult task which had been handed to them in consequence of a change in the security regulations of the United States and in the climate of opinion.

That fact must be kept in mind if we are to understand the apparent inconsistency between the Board's vindication of Dr. Oppenheimer's loyalty and discretion and the recommendation that he should not be reinstated. Dr. Oppenheimer, as is known to all scientists, took a leading part in developing the atom bomb in the United States, and his work for the Atomic Energy Commission since the War has been highly praised by the chairman of that Commission. Of his services here the Security Board says:

"The impact of his influence was felt immediately and increased progressively as his services were used. The Nation owes these scientists, we believe, a great debt of gratitude for loyal and magnificent service. This is particularly true with respect to Dr. Oppenheimer".

On the loyalty issue, in recording their conclusion that Dr. Oppenheimer is a loyal citizen, it adds:

"The Board believes, however, that there is no indication of disloyalty on the part of Dr. Oppenheimer by reason of any present Communist affiliation, despite Dr. Oppenheimer's poor judgment in continuing some of his past associations into the present. Furthermore, the Board had before it eloquent and convincing testimony of Dr. Oppenheimer's deep devotion to his country in recent years and a multitude of evidence with respect to active service in all sorts of government undertakings to which he was repeatedly called as a participant and as a consultant. . . . The Board was impressed by the fact that even those who were critical of Dr. Oppenheimer's judgment and activities or lack of activities, without exception, testified to their belief in his loyalty".

In spite of this clear conclusion that Dr. Oppenheimer is a loyal citizen, the majority of the Board were unable to recommend that "the reinstatement of his clearance would not be a danger to the common defence and security". The case, as has already been indicated, was reopened because of a change in the security regulations and in the climate of national opinion. The accusations against Dr. Oppenheimer considered by the Board fall into two main categories: those which concern his contacts prior to 1943 with Communists or Communist-sponsored groups; and those which relate to his opposition later to the development of the thermonuclear or hydrogen bomb.

Of the first, the majority of the Board found that Dr. Oppenheimer's "continuing conduct and associations have reflected a serious disregard for the requirements of the security system", and they also found "a susceptibility to influence which could have serious implications for the security interests of the country". Of the second they found that his conduct in the hydrogen bomb programme was "sufficiently disturbing as to raise a doubt whether his further participation, if characterized by the same attitudes in a Government programme relating to the national defence, would be clearly consistent with the best interests of security".

In reaching its decision on the first set of facts, which were substantially known to military intelligence when Dr. Oppenheimer was placed in charge of the atom bomb development at Los Alamos and to the Atomic Energy Commission when he became chairman of the General Advisory Committee of that Commission, the Security Board has obviously been influenced by the climate of opinion and the doctrine of guilt by association against which Prof. Commager protested with such clarity and force. Admittedly, Dr. Oppenheimer has shown poor judgment in continuing some of his past associations; but, as the Board itself points out, his sympathetic interests diminished from 1942 to apparent complete rejection in 1946, and they are in part family associations. It asks, indeed, the question whether an individual, who has been a member of the Communist Party or closely associated with it, can later on so comport himself personally, so clearly demonstrate a renunciation of

interest and sympathy, so unequivocally display his zeal for his country and its security as to overcome the presumption of security risk. The Board believes this to be possible and that it should be a part of the security policy of the United States; but in making this assumption, it appears also to be making the naïve if not arrogant concept that, in its own words, "the Government can search its own soul and the soul of an individual whose relationship to his Government is in question with full protection of the rights and interests of both".

Such prescience has scarcely been claimed even under a totalitarian regime, and it is difficult also to accept the Board's contention that the proceedings have shown that such investigations can be conducted with complete disregard of public clamour and private pressures. That such investigations can be conducted calmly, fairly and with dignity signifies little in comparison with the harm which they are liable to do to creative and sensitive minds. The charges brought against Dr. Oppenheimer required examination when they were first made; but the Editorial Board of the *Bulletin of the Atomic Scientists* will not be the only body to whom it will seem contrary to both decency and common-sense to revive them now from the irrelevance to which a brilliant record of national service had relegated them. To do so seems to make a particular security system the master rather than the servant of national interest.

The Security Board does indeed seem to be uneasy on this score. It points out that the protection and support of the entire security system itself has had insufficient public attention, and at least by implication it admits the right of criticism of, or dissent from, that system. Having gone so far it fails, however, to recognize that any particular security system may in its structure or administration have defects which impair the dynamic and creative elements which are the real source of national strength. "It seems to us", writes the Editorial Board of the *Bulletin of the Atomic Scientists*, "a breach of faith on the part of the Government to call upon a man to assume such heavy responsibilities in full knowledge of his life history and then, after he has demonstrably done his best and given the most valuable service to the nation, to use the facts which were substantially known all the time to cast aspersions on his integrity". Others may well feel that in accepting a task which should not have been given to it, the Security Board was led into making claims of competence in areas where it had no title.

The real issue here was, in face of the new security regulations, whether, as a matter of national policy, Dr. Oppenheimer should be employed regardless of the narrow standards laid down for screening a typist or a clerk. Perhaps only the United States could have spared the time and energy of distinguished men to discover whether Dr. Oppenheimer was a security risk according to its standards. Unquestionably he was, but having regard to the framework of American philosophy it was not right to expect the Security Board to make any such distinction even on the ground of critical national need. Only the President can fairly accept responsibility for any such decision, nor can he evade the final responsibility if the climate of opinion forces on the Executive changes in the security system which endanger the real strength of the nation.

One further passage in the Security Board's findings touches on a particular aspect of this question. It was repeatedly confronted with the question whether, in determining the security status of a scientist, the Government must take into account the reactions of, and the possible impact upon, all other scientists. Even here, however, the Board scarcely seems to appreciate the effect of security inquiries and procedure upon scientific and other creative work. The Board recognizes that it is encouraging evidence of the vitality of society when so many scientists spring to the defence of one who is regarded as unfairly attacked; but the deeper issue that an ill-judged security system may endanger the roots of security is not recognized. It is not that scientists, for example, claim any special privilege to be exempt from security regulations or inquiries. The Board itself testifies to their loyalty and responsibility. The Oppenheimer case does, however, seem to raise the fundamental issue of the appropriateness of the whole security system and whether its structure or administration are not, in fact, eroding the basis of a free society.

The second group of accusations regarding Dr. Oppenheimer's opposition to the development of the hydrogen bomb raises an equally fundamental issue. The Security Board found that Dr. Oppenheimer's conduct was sufficiently disturbing as to raise a doubt as to whether his future participation, if characterized by the same attitudes in a Government programme relating to the national defence, would be clearly consistent with the best interests of security. This finding is in contrast, as Mr. Garrison pointed out in the letter already quoted, with the fact that the basic allegations in this matter were regarded as disproved. The Board agreed that Dr. Oppenheimer's opposition to the hydrogen bomb programme "involved no lack of loyalty to the United States, or attachment to the Soviet Union", that his opinions regarding the development of the hydrogen bomb were shared by other competent and devoted individuals, both in and out of Government, and that it could be assumed that these opinions were motivated by deep moral conviction". After the decisions in January 1950 to proceed with the development of the hydrogen bomb, Dr. Oppenheimer did not oppose the project in a positive or open manner, nor did he decline to co-operate in the project, and the allegations that he urged other scientists not to work on the hydrogen bomb programme were unfounded.

Nevertheless, the Security Board concluded that the "security interests of the United States were affected by Dr. Oppenheimer's attitude because they believed that, had Dr. Oppenheimer given his enthusiastic support to the programme, a concerted effort would have been initiated at an earlier date and because, following the President's decision, he did not show the enthusiastic support for the pro-

gramme which might have been expected of the chief atomic adviser to the Government under the circumstances". Dr. Garrison argues that the injection into a security case of a scientist's alleged lack of enthusiasm for a particular programme is fraught with grave consequences to the United States, and his contention is supported by comments of other scientists which indicate that this is the aspect that the majority of scientists in the States find most disturbing.

"How can a scientist", asks Mr. Garrison, "risk advising the Government if he is told at some later day a security board may weigh in the balance the degree of his enthusiasm for some official programme, or that he may be held accountable for a failure to communicate to the scientific community his full acceptance of such a programme?" The Security Board did not find that Dr. Oppenheimer urged other scientists not to work on the hydrogen bomb programme, although it believes that enthusiastic support on his part would have encouraged other leading scientists to work on it. Nevertheless, it found that "if Dr. Oppenheimer had enthusiastically supported the thermonuclear programme before or after the determination of national policy, the hydrogen bomb project would have been pursued with considerably more vigour, thus increasing the possibility of certain success in this field".

To argue thus introduces an entirely new standard of acceptability for employment as a technical adviser. It has not previously been suggested that a government employee or consultant must give his enthusiastic support to official policy. Dr. Oppenheimer was not alone in opposing the development of the hydrogen bomb, at least in so far as his opposition was based on the nuclear technology then existing. Nor does even the Security Board challenge Dr. Oppenheimer's right to hold moral or political opinions opposed to that development. It is admitted that when his opinion was rejected he co-operated loyally in the furtherance of the official programme. To dispense with his services on the ground of lack of enthusiasm, instead of doing so by exercising the right possessed by any government to change its advisers without challenging either their competence or their patriotism, involves grave risk that men of creative, original and independent minds will no longer care to enter the government service, or indeed be accepted for it, and, as Prof. A. Macbeath remarked at Belfast, the only safeguard against major mistakes has then gone.

Mr. N. D. K. Price, writing on this issue of the hydrogen bomb before the Oppenheimer case developed, remarked: "If there were any problem on which the highest public officials should accept their proper responsibility and in which scientific advisers should not be held accountable except for the accuracy of their scientific advice this was the problem. . . . Published articles that attack the motives of scientific advisers will obviously weaken the government's ability to get scientific advice".

The danger of alienating scientific advisers has been emphasized by Dr. Vannevar Bush in an article which advocated an overhaul of the entire system of security clearance within the executive branch of the Government. The comments of other scientists in the scientific press of the United States indicate that it is the security system itself, rather than Dr. Oppenheimer, that is on trial. The issue is one between the positive and the negative concepts of security. The lone scientists on the Security Board and on the Atomic Energy Commission, attaching first importance to the former, were of opinion that Dr. Oppenheimer's services should be retained; their colleagues, guided by the negative concept, voted to dispense with them. In this connexion it should be noted that the Security Board said: "It seemed to us that an alternative recommendation would be possible if we were allowed to exercise mature practical judgment, without the rigid circumscription of regulations and criteria established for us".

There is one further comment to be made here on the introduction of this new concept of enthusiasm as fitness for service. That involves a threat to the freedom of the scientific conscience which seems, indeed, to have troubled the Commissioners. More important, however, even than the possible discouragement to first-class men from entering the service of their country, the introduction of this criteria of enthusiasm destroys the real basis of advice. What a nation requires primarily of its advisers is not enthusiasm but responsibility. That is the condition on which advice is given, and it implies loyalty as well as the judgment and the wisdom to select and apply the relevant knowledge. Responsibility does not and cannot condone the subordination of judgment to any political doctrine or policy.

Once again, therefore, we are brought face to face with the voice of power and responsibility. Unless our advisers are trusted and are allowed discretion, they cannot give us that independent judgment, that unimpeded inquiry and scrutiny which are the source of major and vital advances and the safeguard against major mistakes. Perhaps the most hopeful feature of the whole business is the extent to which these issues have been recognized by American scientists themselves. It is not so much the way in which they rallied in support of Dr. Oppenheimer, with whose opinions and judgments many of them have often disagreed. It is rather that they have recognized with remarkable unanimity that security regulations that enforce a decision which puts a blot not clearly justifiable on the reputation of an outstanding American scientist, generate distrust between American scientists and their government and endanger the readiness of government advisers to give the government the benefit of their best thought, are themselves a danger to the security of the country.

Meanwhile, in the United States other atomic scientists have had their zeal for their work damped by what they regard as the unrealistic standards applied in Dr. Oppenheimer's case and may hesitate to renew their contracts with the Atomic Energy Commission, just as promising young scientists may

now prefer to seek employment elsewhere. Already secrecy regulations and the impediment they offer to the free exchange of knowledge tend to discourage a certain type of the ablest young minds from entering this field. Once the opinion gains ground that scientists in government service have to work under such restrictive conditions or in such an atmosphere of suspicion that creative and original work and the spirit of free inquiry are inhibited, the quality of the State service will be irreparably impaired.

In Britain, as in the United States, national security depends primarily on the country's ability to enlist in its service a sufficient proportion of the ablest minds among its scientists and technologists and allowing them to work under conditions which give full scope to their originality and vitality. Security regulations which do not subserve this condition themselves endanger national security. The protests that have been forthcoming over the Oppenheimer decision may indeed offer some safeguard that it will not form a precedent for "insidious encroachments by men of zeal, well-meaning but without understanding", which are the major threat to national security as well as freedom. More positively, it may perhaps be hoped that the co-operation which will be demanded if the United States is to participate effectively in the new world agency to promote the growth and spread of atomic energy for peaceful purposes, announced by President Eisenhower on September 6, will itself encourage the realistic appraisal of the security system which American scientists have urged and the formation of a climate of opinion in which the balance of freedom and security and the issues of responsibility and power are more clearly understood, and guarded with imagination and understanding as well as zeal.

As has been said, the manner in which Dr. Oppenheimer has been dismissed makes it difficult for the free world to avail itself of the services of the man whom Dr. Smyth describes as "one of the most knowledgeable and lucid physicists we have" without raising awkward issues.

But the really important questions which the Security Board and the Atomic Energy Commission have left unanswered are not concerned with Dr. Oppenheimer at all, or at least only indirectly. Was it really necessary for three such distinguished men to spend their time and energy on determining the answer to a question which was obvious to common sense? Apart from the question whether even the most richly endowed nation can afford to divert an unlimited amount of its man-power to security investigations, the contrast between the ambiguous answers produced after so much voluminous inquiry and the swiftness and perspicacity with which Sir John Woods's committee investigating the Crichel Down episode in Britain reported on issues touching the public interest no less vitally is startling. Almost inevitably it suggests that there may be substance in what some American scientists are saying, and that Dr. Oppenheimer has been dismissed because his opinions were unpalatable to the authorities, and particularly the military authorities, who have chosen this retrograde method of removing an adviser so as to minimize the possibility that others may avail themselves of his advice or services. Meanwhile, grave damage has been done to the co-operation and understanding between scientists and government, without which no effective system of defence can to-day be developed. To establish conditions in which the scientific adviser can make his full and most effective contribution to the tasks of defence and of peace is an imperative over-riding necessity for the free world, and until clear answers are given to the questions which are raised by the case of Dr. Oppenheimer the belief may well grow that its significance is to be seen, not in comparison with the recent Crichel Down episode, but in the analogy with the case of Dr. Dreyfus two generations ago.

SIR WILLIAM PETTY: A GENIUS OF THE SEVENTEENTH CENTURY

Sir William Petty

Portrait of a Genius. By E. Strauss. Pp. 260. (London: The Bodley Head, 1954.) 25*s*. net.

THE mid-seventeenth century was for England an exciting and expansive era. Increasing population and wealth, with accompanying changes in the structure of society, created new problems of political organization; the development of industrial technique and sea-borne trade gave a new importance to commercial policy; and the scientific movement offered not only the greatest intellectual stimulus of the time, but provided also a hope that through its mastery of Nature the material progress of mankind would steadily advance. Many reactions to the opportunity of the age were possible. Some men prospered in wealth while understanding little of the changes that had made their success possible. Others who achieved distinction in science or philosophy were passive to the social currents by which they were borne. A peculiar interest in the career of Sir William Petty (1623–87) is that he was of both camps—a *parvenu* opportunist who had won wealth and title by exploiting the devastation of Ireland, and at the same time a philosopher, the father of political economy and an Original Fellow of the Royal Society.

In a tough society Petty was no weakling, as Mr. E. Strauss shows. He was ambitious to rise in the world, and not too scrupulous. An accident took him from the sea to a Jesuit College; a little learning brought him to Oxford, the medical profession and to many useful friends. But Petty was destined to be neither a Sydenham nor a Radcliffe. Ireland called him, as it had called all adventurers since Elizabeth's reign. Although he began with little capital, the Down Survey and the distribution of land to Cromwell's veterans yielded him a wonderful opening, so that by outwitting the administration and shrewd bargaining with the soldiers he emerged possessed of at least thirty thousand acres and a heritage of litigation.

With wealth assured, Petty's ambition turned to politics. Mr. Strauss analyses the means by which this servant of the Cromwellian régime secured something more than tolerance from the restored Stuarts. He won rather less by his change of heart than some of his colleagues in the Royal Society. His massive proposals for increasing population, production and

revenue were ignored. Even the scientists were surprisingly indifferent to his venture with the double-bottomed boat. This was partly because (as Mr. Strauss says) Petty preserved ideals and policies which were no longer in favour, such as opposition to the aggrandisement of France; but it was also no doubt due to a more fundamental disability. Attractive as he was to his friends, and greatly as he impressed them by his intellectual capacity, Petty was a more difficult character than Mr. Strauss seems willing to admit. His one great exercise in authority and administration—the Down Survey—proves that he had a superlative ability for arousing hostility and envy; and there is no sign that their main cause, Petty's love of money, diminished with age. Rather, his every scheme for enriching England was designed to enrich Petty, too. Perhaps, as with other philosopher-kings, it was best for the philosopher in Petty that his kingship should remain frustrated.

It is when he comes to examine Petty's writings on political economy that Mr. Strauss's claim of genius is best sustained. The Down Survey (1655–56) was indeed an astonishing feat of organization, but it should be remembered that it was effected with the aid of a disciplined military force; and important as the Survey was for the cartography of Ireland, Petty contributed nothing to the development of surveying methods. It was in his riper years as a cabinet statesman, in the many papers that remained unpublished until after his death, that the originality and power of Petty's mind were revealed. For if his schemes for the demographic and economic reform of England were often fanciful in detail, they were based on theoretical conceptions which (in Mr. Strauss's words) "provided the starting-point for the growth of classical economic science up to the time of Adam Smith, David Ricardo and Karl Marx". The foundation of these conceptions was Petty's notion of wealth, far removed from the crude bullionist equation of wealth with plenty of money, as residing in a dense and productive population. Only less original was his grasp of the importance of statistical information, though Mr. Strauss concludes that John Graunt's share in the authorship of the famous "Observations upon the London Bills of Mortality . . ." was far from trivial. Petty's conclusions were necessarily often based on numerical conjectures, and he added nothing to the mathematical aspects of this subject; what he did do was to indicate the kind of information that could usefully be collected, and the type of answer that statesmen and administrators could extract from it.

As a natural scientist, on the other hand, Petty had no great merit. His Baconian ideas were rendered outmoded by the growth of disinterested research in the several sciences. Something of his intellectual virtues and defects are portrayed in his remark in 1687 that "As for Mr. Newton's book, I would give £500 to have been the author of it". His one great adventure in applied science, the double-bottomed boat, proved a dismal failure. In navigation, as in politics, the brilliant amateur was outdistanced by plodding professionals.

Mr. Strauss has given a full and interesting account of this extraordinary career, which is a fitting supplement to Lord Lansdowne's volumes of twenty-five years ago. He has placed Petty firmly in his historical context, and evaluated skilfully the merit of his varied writings. If in seeking to justify the unbounded admiration felt by many better-known contemporaries (including John Evelyn and Samuel Pepys) for this rather neglected figure in the "century of genius", Mr. Strauss has made some claims for Petty of which the strength is not immediately obvious, he has nevertheless given a fair picture of the weaknesses in Petty's intellect and character. He has written an excellent book.

A. R. Hall

MINERALS USED IN INDUSTRY

Minerals for the Chemical and Allied Industries

By Sydney J. Johnstone. Pp. 692. (London: Chapman and Hall, Ltd., 1954.) 75*s*. net.

THIS is a concise, encyclopædic account of the sources, properties, uses and standard specifications of a great variety of mineral substances that now find application in modern chemical and related industries and, incidentally, in the metallurgical industry. The term 'mineral', as used here, is to be interpreted in its very broadest sense, implying substances obtained out of the earth, either directly, or indirectly from complex ores, and also certain synthetic derivatives of such minerals. Thus, the main section headings include such diverse materials as slate waste, rhenium, wollastonite, perlite, mercury, nitrates and ochre. In fact, many of the minerals dealt with are described under sections bearing the name of the principal element or substance, metallic or otherwise, entering into their composition, so that other headings are aluminium, titanium, iodine, sulphur, silica, and so on. The main sections are in alphabetical order, an arrangement doubtless convenient to the commercial users for whom the book is primarily intended. An adequate index assists in rapid reference to more specific minerals. There is no main heading for iron (a rather surprising omission), which seems to be accounted for by the fact that the materials described are essentially those in use or potentially useful for chemical rather than metallurgical industry, although in the case of many other metals their metallurgical applications receive mention. However, certain naturally occurring ferruginous minerals are included under other headings, and the applications of other metals—for example, manganese and zirconium—in iron metallurgy are mentioned in the appropriate sections.

The fact that this book has been prepared by the former principal of the Mineral Resources Department of the Imperial Institute, London, who also served as head of the Commodities Section of the Ministry of Economic Warfare during the Second World War, is sufficient guarantee of its authoritative character. It is based on a series of articles that he published in *The Industrial Chemist and Chemical Manufacturer* between 1946 and 1949. Much new material has been incorporated, however, bringing the text thoroughly up to date; and accounts of a number of minerals not included in these articles have been added. Each section concludes with a selected bibliography of sources from which more detailed information is obtainable. Statistical details of sources and production in recent years are given, so far as they are available, and also references to countries that were able to produce increased quantities of certain materials during the War. All this material has been collected from many widely scattered sources, and presented concisely in an easily accessible form.

The book makes instructive reading for all interested in economic minerals and their uses, and is particularly informative, for example, on the uses to which some of the rarer metals are now being put. It will prove invaluable to the industrial chemist, for whom it is especially intended; but should also be useful, as a reference book, in those technical and other educational establishments where the curriculum includes the economic applications of chemistry and mineralogy.

V. A. EYLES

THE FIRST COLONIZATION OF BRITAIN BY FARMERS

The Neolithic Cultures of the British Isles

A Study of the Stone-using Agricultural Communities of Britain in the Second Millennium B.C. By Prof. Stuart Piggott. Pp. xix+420+12 plates. (Cambridge: At the University Press, 1954.) 70*s*. net.

WITH the aid of soberly scientific imagination and historical insight, the fragmentary results of fossilized behaviour that constitute the archæological record have been here interpreted by Prof. Stuart Piggott as documenting the first colonization of the British Isles by farmers, the adaptations of their exotic cultures to the insular environment and the reactions of surviving Mesolithic 'natives' to the impact. The result is no tedious catalogue of invasions (though to explain the facts the author has to postulate at least six distinct bands of "Neolithic" immigrants apart from several groups of "Beaker folk"), but genuine history—at least economic history—as concrete as the limitations of archæological data allow; for example, the lively account of the autumn round-up of stock in "causewayed camps" is no product of fancy, but a legitimate inference from observed phenomena that have been factually described. For the archæological data are here assembled, classified and presented so fully that a sceptical reader can discern possible inconsistencies even in statements that the author accepts (for example, a "cremation" of which no burnt bone survives; the account of the Baltinglass cairn is vitiated only by a defect in the published plan that Prof. Piggott justifiably followed) and illustrated by figures and maps that are artistic as well as instructive. As a result, Prof. Piggott's work is a standard and indispensable source-book from which all further work on the problems of the period must start. For problems still are left.

Most of the material so exhaustively surveyed has been accumulated during the past twenty-five years, much in the past decade, while some of the most reliable data are due to the author's own excavations at well-selected sites. At the same time, Prof. Piggott has extracted every scrap of serviceable information from older accounts of digs into flint mines and long barrows. The interpretative concepts are likewise novel and original. As to chronology, the book's sub-title will advise the reader that the Neolithic period surveyed does not begin, as it would have a quarter of a century ago, with the end of the Pleistocene. Its end will still surprise many readers; "Neolithic" for Piggott does not end, as has been assumed for the past fifty years, with the advent of "the Beaker folk". Though typologically early bronze weapons are doubtless found, albeit very rarely, in their graves, and exports on the Continent of Europe imply even the contemporary existence of a school of local metallurgy at least in Ireland, societies here described undoubtedly continued to maintain purely Neolithic traditions after the Beaker invasion and down to the rise of the Wessex culture. After all, on Montelius's system for Scandinavia, Neolithic IV coincides with Bronze Age I, and a similar usage would be legitimate here.

The Beaker invaders are not here treated among "the stone-using agricultural communities of Britain"; they are excluded not as consumers of metal ware, but as exponents of "the novel rite of individual burial", while "some form of collective burial appears to be characteristic of all the neolithic cultures here described". Therewith, "collective burial" too is given a novel sense, being applied to cremations interred in individual graves, if these are grouped in closed cemeteries, as much as to the burial of several persons' remains in a common tomb, to which latter rite the term had hitherto been restricted. Admitted cases of individual burial in "Neolithic" cultures are explained as due to the influence of the Beaker invaders, even though at Linch Hill such a burial was stratigraphically prior to an interment with a Beaker.

Original, too, and fruitful is Prof. Piggott's concept of "Secondary Neolithic cultures", in which such elements as "can be regarded as intrusive" are "inextricably mixed with other features which have a long local ancestry in Mesolithic cultures", whereas the Primary cultures, associated with the first farmer-colonists, should represent "a virtual transfer of French early Neolithic traditions to this country". But in the sequel it is suggested that the distinctive secular monuments of the colonists—the "causewayed camps" (which are really cattle corrals)—together with the techniques of skin-dressing illustrated in them, may be due to "intermixture with indigenous hunter-fishers", while their long barrows might have been as appositely compared to Megalithic tombs in north-east Germany as to the *tertres allongés* of Morbihan. On the other hand, Secondary Neolithic pottery of the Peterborough class is so like the pitted ware of Sweden that the author inclines to regard its "appearance as an indication of settlement in south-east England of people arriving by sea from Scandinavia". Now, since the book went to the press (in 1951), Becker has shown that the makers of pitted ware played just the same part in the distribution of flint axes in Scandinavia as Secondary Neolithic folk played in Britain in the remarkable trade in axes from the Langdale, Penmaen Mawr and Antrim factories which systematic petrological examination has revealed recently, but in time for description by Prof. Piggott. This three-year interval between composition and publication must also be remembered in connexion with other comparisons with North European material. The author has just failed to translate the older Danish–Swedish chronological terminology into that adopted during the past five years, and consequently seems to have inverted the chronological relations between the Beacharra C and Peterborough phases here, in so far as these are deduced from North European parallels. In the precocious science of prehistoric archæology progress is so rapid and publication has become so slow that any book must be to some extent out of date when it is issued. Prof. Piggott has written an exhaustive and authoritative account of Neolithic Britain as it appeared in 1951.

V. G. CHILDE

A Bibliography of the Research in Tissue Culture, 1884 to 1950

(An Index to the Literature of the Living Cell Cultivated in Vitro.) Prepared by Margaret R. Murray and Gertrude Kopech. Vol. 1: A–K. Pp. xxviii+840. Vol. 2: L–Z. Pp. 841–1742. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 24 dollars the set.

THIS monumental bibliography of the literature on tissue culture, which occupies two large volumes, is indeed a remarkable achievement. The plan to produce this work was conceived in 1946 at the Hershey Conference and has been sponsored throughout by the Tissue Culture Commission, which was founded at this meeting, and by its successor, the Tissue Culture Association. When the scheme was first launched, the vast size of the literature was not fully realized, and the authors and sponsors had to surmount many unforeseen difficulties, both financial and editorial, before the project was at length completed.

In the preface, tissue culture is defined as "the maintenance of isolated portions of multicellular organisms in artificial containers outside the individual for considerable periods of time". To prepare the book, "29,000 articles were read in their entirety"—a truly horrifying thought—and, from these, 15,000 were selected as being covered by the definition; this number was expanded by excellent cross-indexing to 86,000 entries.

It is astonishing to discover how much work has been done by means of the tissue culture technique in a wide variety of fields. To have this exhaustive collection of references assembled in one book, however large, is a blessing not only to all those who use the method, but also to many others who are concerned with the information provided by experiments on tissue cultures. The authors are to be warmly congratulated on the scholarly way in which they have accomplished their formidable task, and they can rest assured that grateful colleagues throughout the world will "arise up and call [them] blessed".

Journal of the Institute of Metals

Vol. 80, 1951–52. Editor: N. B. Vaughan. Pp. xvi+728+113 plates. (London: Institute of Metals, 1952.)

THE present volume is the first to appear in the enlarged size (11 in. × 9 in.). This new format has enabled diagrams and photographs to be reproduced more satisfactorily; but the volume of 728 pages weighs more than 5½ lb. and is too heavy for convenient handling, while its cloth binding is insufficiently strong to stand up to normal laboratory or library use. The volume contains seventy-seven papers, and a further disadvantage of this large size is that a single reader in a library immobilizes seventy-six papers besides the one he is consulting. It is to be hoped, therefore, that future volumes will be smaller and published at more frequent intervals.

Except for its inconvenient weight, the volume is excellent. It is well and clearly printed, and the standard of reproduction of tables, diagrams and photographs is admirable. The papers cover a wide range of subjects, and the majority can be read from the point of view of general scientific interest, quite apart from industrial applications. Work on the structure of metals and alloys is prominent, and the volume includes the presidential address by Dr. C. J. Smithells, the twenty-second Autumn Lecture on "Electrochemistry and the Science of Metals" by Prof. R. Piontelli, and the forty-second May Lecture by Dr. J. J. P. Staudinger on "The Place of Plastics in the Order of Matter". There are also a summary of a discussion on metal economics and a symposium on equipment for the thermal treatment of non-ferrous metals and alloys. W. Hume-Rothery

Synthetic Organic Chemistry

By Romeo B. Wagner and Prof. Harry D. Zook. Pp. xii+887. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 92*s*. net.

THIS comprehensive work aims at giving a concise summary of the chief synthetic methods used in organic chemistry for preparing compounds of single and dual function. For this purpose the authors have undertaken an exhaustive examination of twenty of the leading journals and books dealing with organic chemistry from 1919 to 1950.

The thirty-nine chapters bear such headings as acetylenic compounds, halides, ethers, lactones, *iso*cyanates, amines, imines, hydrazines, diazo and diazonium compounds, and sulphonic acids. As an illustrative example, Chapter 24, dealing with amines, adduces forty methods for preparing this type, including the reduction, or the hydrolysis, of various other types; degradation of amides, acyl azides and hydroxamic acids; ring dehydrogenation; and various ways of applying Grignard reagents. A short discussion, with copious references for each method, is followed by twelve tables which summarize the preparative methods, yields and physical properties of some seven hundred individual compounds listed under the heads of amines, diamines, olefinic and acetylenic amines, halo- and hydroxy-amines, amino-ethers, -aldehydes, -ketones, -acids, -esters and -cyanides. The chapter closes with a list of 561 references to original sources finding mention in it.

The enormous amount of information in this time-saving compendium is set out clearly and systematically, the book is well printed, and it can be commended to organic chemists and biochemists as a reliable and up-to-date guide through the maze of modern synthetical methods. John Read

The Heron

By Frank A. Lowe. (New Naturalist Special Volume.) Pp. xiii+177+9 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 18*s*. net.

BOOKS about birds continue to come from the publishers in steady numbers and are evidence of the ever-growing appreciation of ornithology. In "The Heron" Mr. F. A. Lowe has written an interesting monograph and an excellent addition to the "New Naturalist" series of volumes. Based on long observation of the heron breeding colony in Dam Wood, Lancashire, his book ranges over world distribution and populations, breeding biology, the mechanics of flight and dispersal, the heron in history and folk-lore, etc. It is a painstaking and thorough survey, written in an unpretentious style, that will be read with pleasure alike by the experienced ornithologist and the recent recruit to the ranks of bird-lovers.

The illustrations range from maps and diagrams to photographs taken in the wild, and include as frontispiece a photograph in colour of a heron at its nest. Where all are so excellent, it seems invidious to carp; but it would certainly have been pleasing had it been possible to include one or two heron portraits by outstanding artists, including an example of the heron in Japanese art. Frances Pitt

PHYSIOLOGICAL ASPECTS OF THE HEATING AND VENTILATION OF HOUSES IN BRITAIN

AT the recent meeting in Oxford of the British Association, the first session of Section I (Physiology), held on September 2, dealt with various physiological aspects of heating and ventilation, the emphasis of the papers being on the requirements of houses in Great Britain.

In his introduction the chairman, Dr. Thomas Bedford, gave a brief survey of the results of recent studies of thermal comfort and the assessment of environmental warmth. It can be concluded from recent research in the United States that for satisfactory ventilation the supply of fresh air should be at the rate of not less than 600 cu. ft./hr. for each person, and this standard had been accepted by the Egerton Committee as one of the requirements for post-war housing. People doing light work during the winter months in Great Britain liked a temperature of about 65° F. and were reasonably comfortable at temperatures of between 60 and 68° F. With a suitable temperature there should be adequate but not excessive air movement. At room temperatures of about 65° F. the air speed should be between 20 and 40 ft./min. At lower speeds complaints of stuffiness are likely, and at higher speeds sensitive persons will complain of draughts.

Investigations have confirmed that with a given level of warmth most people find conditions pleasanter when the boundary surfaces of a room are warmer than the air than when they are cooler. It is undesirable that the warmth around the head should be appreciably greater than that near the floor. The gradient of air temperature over the height of a man should not be more than 5° F. When a room is heated by panels embedded in the ceiling, the elevation of the mean radiant temperature at head-level due to the warm ceiling should not exceed 4° F. Many buildings are now warmed by heating the floors. Research nearly completed shows that for sedentary people the temperature of the floor surface should not be higher than 75° F.; but people who are moving about can tolerate a rather higher temperature. These figures relate to rooms with an air temperature of about 65° F.

Various scales of warmth have been used for making allowance for different combinations of the individual factors which make up the thermal environment. The best known of these is the American scale of effective temperature. This makes no specific allowance for radiant heat, and during the Second World War it became necessary to attempt some adjustment of the scale to allow for radiation effects. Such an adjustment has been made by using the temperature of a black-globe thermometer instead of the air temperature in calculating the effective temperature. Recent physiological research carried out at the R. N. Tropical Research Unit, Singapore, has shown that this method of adjustment gives good results.

War-time studies have led to certain criticisms of effective temperature as an index of the stress imposed by work in hot environments, but a recent study of the bases of these criticisms has led to the conclusion that effective temperature, properly used, remains a valuable index of warmth. Finally, it was suggested by Dr. Bedford that attention should be given to local methods of warming a person rather than the whole room or the whole house, especially with reference to the requirements of the aged. Dr. E. F. DuBois had asked: "Why overheat 100 tons of house and furniture, when all that is necessary is to warm 100 lb. of grandmother?"

Prof. G. P. Crowden spoke on the heating and ventilation requirements of dwellings. He outlined the climatic factors which affect the control of body temperature and the comfort of the individual, and then detailed the standards set out in the codes of practice drawn up by the British Standards Institution. In living-rooms the temperature should lie between 60 and 68° F. and in bedrooms between 55 and 57° F. In both, the relative humidity should be between 30 and 65 per cent, with a fresh air supply of 600 cu. ft./hr. per person. For kitchens a temperature of 60° F. is specified, with a relative humidity of less than 70 per cent, and the supply of fresh air should be at least 2,000 cu. ft./hr.

Prof. Crowden then went on to describe tests that had been carried out in experimental rooms of the type described as 'kitchen/living-room', with housewives and men of varying ages as the experimental subjects. These tests showed that the provisions for heating and ventilation make it possible to maintain the specified conditions.

When housing schemes were again undertaken after the Second World War, it was evident that building resources would be stretched to the utmost, and methods of economy in building were examined. One obvious way of saving in both cost and materials was to reduce the heights of rooms. Generally it was not permissible to build houses with rooms less than 8 ft. in height; but it was thought by many that rooms 7 ft. 6 in. in height would be quite satisfactory. Others feared that houses with the lower ceilings would be unsatisfactory on grounds of health or of comfort. Prof. Crowden described a survey of some trial houses that were built with rooms only 7 ft. 6 in. high. The families who lived in them did so in comfort. Very few expressed the opinion that they would prefer higher rooms, and the majority had not noticed that the ceilings were lower than usual. The conditions specified in the codes of practice were readily maintained in these houses.

When ordinary gas wash-boilers and cookers were used in small kitchens these became undesirably hot and steamy, and the air was contaminated with products of combustion, unless the ventilation greatly exceeded the 2,000 cu. ft. of fresh air per hour laid down, or unless flues were provided to remove the products of combustion.

Two examples were given of the failure of occupants to make proper use of provisions for ventilating their houses. In one house the excessive use of draught-excluding devices made it impossible to use a solid-fuel fire, while a gas fire made the air unpleasant, even though the heating was inadequate. In the second example, the deliberate restriction of ventilation resulted in four deaths from carbon monoxide poisoning due to the incomplete combustion of coal gas.

In a paper on problems of working conditions in the home, Dr. J. R. Brown described experiments in which women engaged in washing clothes were studied, the work being done without the aid of washing machines. Careful measurements were made of the thermal environment as the work proceeded, the subjective impressions of heat and of moisture of the experimental subjects were noted, their blood

pressures and pulse-rates were measured and used for computing the Crampton index of vasomotor tone, and the electrical conductivity of the skin was measured. From experiments carried out under control conditions it was concluded that changes in the Crampton index were related to changes in thermal stress. The numerical value of the index declined as the women subjects felt hotter and more fatigued. It has been found that, until the skin becomes visibly wet with sweat, there is a linear relation between its electrical conductivity and the number of active sweat glands.

Dr. A. Parker spoke on house heating and atmospheric pollution. Domestic chimneys are responsible for a million tons of smoke a year and for a million tons of sulphur dioxide, and the solution to the problem lies in the use of smokeless fuels—gas, electricity and coke—in proper balance. Problems of economics as well as fuel technology arise here. Only one day's supply of gas can be stored, and it is impracticable to store electricity on a large scale, so that the main stand-by must necessarily be solid fuel. Coke should not be regarded as a surplus product arising from the manufacture of gas, but rather the needs for coke and for gas should be taken into account together. People should regard coke as a valuable smokeless fuel in its own right, and not merely as partly-used coal. Dr. Parker thinks the problem is not insoluble. In Britain, he said, people insist on having open fires, and such fires are perhaps desirable in this climate, but there is no prospect of burning bituminous coal in such fires without creating smoke. When convective methods of heating are used, people tend to demand an air temperature about 8° F. higher than with radiant heating, with consequently greater fuel consumption. It might be suggested that district heating should be extended; but with this form of heating it is usual to make a weekly charge for heat without reference to the quantity used, so that the consumer has no incentive to practise economy, with the result that the amount of fuel used per house with district heating is greater than with open fires.

Mr. J. B. Dick spoke about factors of design and construction affecting heating and ventilation in dwellings. It is the experience of the Building Research Station that, with an internal flue, about 40 per cent of the heat from an open fire is delivered into the house, and with such a fire an acceptable standard of comfort can be obtained at lower cost than with a hot-water radiator. It is important not to provide a heating system that will be too costly for the householder to maintain.

Recent improvements in construction were described. An 11-in. cavity wall with a foamed-slag inner leaf has an overall thermal transmittance of only two-thirds that of an 11-in. cavity wall entirely of brick, and a transmittance of less than half that of a solid 9-in. brick wall. The use of glass wool for roof insulation was described. Besides reducing fuel consumption to maintain a given air temperature, good thermal insulation also raises the temperature of the inner surface of external walls and thus enhances comfort. Temperature gradients can be caused by the convection from cold walls or windows. Better insulation of the walls and tubular heaters beneath windows can cure this. Floor heating also helps to prevent these gradients, and when heating is by the admission of warmed air this should enter at low level and air exits should be placed at high level.

The temperatures maintained in houses depend not only on the preferences of the occupants, but also on the cost. Thus, in some experimental houses the temperatures in the living-rooms at 9 p.m. commonly averaged 65° F., but during cold weather the figure fell to 60° F. It was evident that the householders would not pay for the heat then required to maintain a temperature of 65° F. With improved insulation some of the potential saving of fuel may not be realized because higher temperatures are likely to be maintained by the occupants. Hence emphasis must be placed on better insulation without increased capital cost. One way in which this can be achieved is by use of the foamed-slag inner leaf in cavity walls.

Dr. C. G. Douglas, who opened the discussion, believes that the problems of heating and ventilating factories and offices are easier than those relating to houses. Instrumental methods have been devised for the study of the indoor environment, and the difficulties that now arise are mainly economic. It is important to consider what could be done to provide comfortable warmth for aged people with limited resources. The high cost of coal has driven many people to use kerosene for supplementary heating.

AHMEDABAD TEXTILE INDUSTRY'S RESEARCH ASSOCIATION

By Dr. VIKRAM A. SARABHAI
Director

On April 10, Mr. Jawaharlal Nehru, Prime Minister of India, opened the new laboratory building at Navrangpura, Ahmedabad 9, of the Ahmedabad Textile Industry's Research Association, the foundation stone of which was laid in November 1950 by the late Sardar Vallabhbhai Patel, Deputy Prime Minister of India. The Association is modelled on the same lines as the research associations in Great Britain, and this constitutes the first enterprise of its kind in which industry and the Government of India have co-operated in the field of research. The past five years have witnessed the growth in India of a chain of national laboratories inspired by Sir Shanti Bhatnagar, director of the Council of Scientific and Industrial Research, and Sir Shanti has also been actively associated with the growth and development of the new Association at Ahmedabad, which is the second largest centre of the textile industry in India.

The idea of establishing a textile research laboratory maintained by the joint effort of industry and the Government of India was first conceived by the Ahmedabad Millowners' Association in 1944, and the Ahmedabad Textile Industry's Research Association was registered in December 1947. Its seventy-one founder-members made an initial contribution of approximately £370,000 towards the initial expenses, and the Government of India gave approximately £145,000. The recurring expenses are shared equally by industry and the Government. Recently, membership of the Association was thrown open to mills all over India, and co-operative research is now increasingly made use of by the premier industry of the country.

The laboratories are on the Gujarat University campus and consist of a multi-story central block, covering an area of 100,000 sq. ft., which accommodates the library, offices and laboratories of the various research divisions, the administrative offices, the stores and precision workshop, and the services in a basement. The block is connected at one end to

a single-story building which houses the pilot mill. At the other end are situated a cafeteria and an auditorium. The pilot mill is equipped with complete machinery for spinning, weaving and chemical processing, with facilities for experimenting under a variety of conditions. The physical testing laboratory has a comprehensive range of modern testing instruments for fibres, yarns and fabrics. The unit plant laboratory has a number of laboratory models of standard dyeing and printing machines and will also be equipped in the near future for some of the unit processes of chemical engineering. The entire building is air-conditioned for comfort, except for the physical testing room and the pilot mill, which have separate air-conditioning to maintain required constant temperatures and humidities.

Even though the laboratory building has only now been completed, the work of the Association commenced about five years ago in the Science College at Ahmedabad with the recruitment of staff for statistics, chemistry, physics and psychology. Recognizing the increasing importance of industrial psychology and the science of management, the Association decided from the outset to include these in its organization. It was also felt that during its early years the Association should commence its work with the utilization of existing scientific knowledge and apply this for the immediate benefit of the industry. Emphasis was deliberately placed on operational research aimed at standardization and rationalization of existing processes and work methods, and on applied research designed to introduce developments of practical use to the industry. This was done with the view of fostering scientific consciousness among those who work in the industry and creating confidence in the practical utility of applying the scientific method to the problems of industry.

Operational and applied research is generally carried out in the mills in collaboration with the technical staff of the mills. At all stages of the experiment, critical evaluation is continuously done in frequent conferences among the staff of the Association and in discussions with mill management and technicians. After the successful completion of experimental studies in two or three mills, the results are published in the form of research notes. This, however, constitutes only half the work. Successful implementation and translation of the benefits to industry are equally important tasks on which the Association has placed great emphasis. It believes it to be its duty to demonstrate without cost to its members, in their own mills, the full utility of implementation of its research work. However, every effort is made to ensure that its resources are not diverted to routine operations which legitimately fall within the domain of individual mill management. When circumstances require that the Association should be engaged in routine services, separate units are created for this purpose. In this way the Association operates routine physical and chemical testing laboratories and provides servicing and supervision of quality control, training-within-industry programmes and other management techniques to industry. The cost of these units is defrayed by the mills which participate in these benefits.

To-day the Association has eight Divisions dealing with Physics, Chemistry, Statistics, Psychology, Liaison, Technology, Library and Documentation and Administration.

Pending the establishment of the Textile Technology Division, the Physics Division mainly concentrated during the initial years on problems of spinning. It modified the micro-sample spinning technique developed in other laboratories so that a sample of one pound of cotton may be spun in a short time on the usual mill spinning plant under mill conditions of speeds, settings, etc. The yarns produced by this small-sample spinning method check well in lea strength with the yarns produced by the normal large-scale mill processes. This technique has also been used for investigating the application of various spinning aids and in the investigation of blending of cottons. A study has been undertaken of the fibre length distribution and the evenness of the material under process at various stages in spinning. This Division has a well-equipped optics laboratory in which work is being done at present on a study of the adsorption of dyes and other chemicals on the surface of textile materials. Attempts are also being made to correlate the degree of orientation of mercerized fibres with lustre and to use the X-ray technique for determining the degree of mercerization. A modest beginning in instrumentation and electronic developments has been made by creating a separate section for these in the Physics Division.

The Chemistry Division started initially with a survey of the various textile chemical processes in the member mills of the Association and the determination of optimum conditions for these processes. A detailed study of sizing practice was made, and simple experimental methods for the evaluation of sizing materials and methods were demonstrated to mills. Extensive studies were also made to assess the value of tamarind kernel-powder, an indigenous material, as a sizing material for cotton warps for both bleached and grey sorts. Suitable modifications were worked out to overcome the objectionable reddish colour of this material. A long-term fundamental study of sizing has been planned, and work on this programme has been started very recently. Attempts are also being made to produce improved finishes, using so far as possible indigenous materials. Three such processes have been worked out on a laboratory scale and will shortly be tried in mills on a pilot-plant scale. In order to explore the possibilities of mercerizing textiles made from Indian cottons, an extensive study has been undertaken on a comparison of the mercerization of different cottons (Indian, African, American and Egyptian) in fibre, yarn and cloth stages. The Chemistry Division also maintains a technical service which undertakes investigation of a number of production problems from the chemical processing departments of member mills.

The Textile Technology Division has been created this year with the arrival of machinery for the pilot mill. Among the problems that are being taken up for investigation are (1) the relationship between individual fibre characteristics of a blend and the properties of the yarn and its weavability, and (2) the effect of yarn conditioning, atmospheric conditions and loom tensions on weavability.

The main effort of the Statistics Division has been directed to the development and application of quality control methods to the textile industry. With the Association's collaboration, quality control sections have been established in about twenty-four mills, and statistical methods have been applied by these sections to improve operational characteristics such as breakages, uniformity, waste, damages and efficiency. The Statistics Division has also carried out a number of short-term experiments in spinning,

including studies on the effect of mixing soft waste with cotton, the effect of vibrating bobbins, the effect of different speeds and settings in processing, a comparison of two and three passages of drawing, and an improved method of ribbon lap preparation. Theoretical studies of machine interference have also been made and are being checked with the results of actual mill working. At present the quality control technique is being extended to chemical processing. The possibility of introducing acceptance sampling is also being explored. The Division maintains a computing section to analyse the data coming from various Divisions as well as from the quality-control sections of mills; it publishes a quality-control bulletin incorporating the data collected by the various quality-control sections in mills and the results of experiments carried out by them, and conducts classes for training technicians in statistical methods.

The Psychology Division has been concerned mainly with problems of attitudes, labour management relations, supervisory training, incentives, time-and-motion studies, the effect of physical working conditions on the health of workers and their efficiency, etc. A number of interesting results have been obtained in these various fields, some of which have found practical application on a large scale in mills. A project was conducted during 1950–51 in collaboration with Prof. Gardner Murphy, Unesco consultant to the Government of India, in order to study labour-management tension within the textile industry. As a result of this study, the need for supervisory training was emphasized and training-within-industry programmes were started in 1953 to fulfil this need with the technical assistance of the International Labour Organization. Thirty-one mills are participating at present, and in the short period of one year 2,884 supervisors have been trained. The three training-within-industry programmes have been translated into the Gujerati language so that a greater number of supervisors can participate in them. At the joint request of organized industry and labour, the Psychology Division has worked extensively on assessment of work loads in the various occupations of the industry and on applying the job evaluation methods for recommending a scientific wage structure.

Recently the newly established Liaison Division has taken over, from the research divisions, primary responsibility of maintaining close contacts with member mills and the quick translation of the Association's research into routine industrial practice.

With the completion of the first five years of the Association, the need for a properly balanced research programme covering both fundamental and applied problems has been increasingly felt. Such a programme, where fundamental and applied research would complement one another and constantly provide new ideas, has now been initiated. With technical assistance from Unesco, a project for the study of the nature of macromolecules has been started. An equilibrium centrifuge and gas adsorption apparatus have been set up. Some of the other fundamental problems in this programme are the preparation and properties of colloid solutions with special reference to spinning aids; the spectrophotometric, colorimetric and chemical study of adsorption of substances on textiles; changes in the surface and mechanical properties and in the fine structure of textiles, caused by processes such as sizing, dyeing, mercerizing and finishing; the theory of tensile strength of yarns; the relation between structural geometry and mechanical properties of fabrics; and morale and attitude surveys. Along with the national laboratories of India, the Ahmedabad Textile Industry's Research Association is playing a significant part in tackling the great and important problems which face India to-day.

ABNORMAL PROPERTIES OF HISTONES FROM MALIGNANT CELLS

By Dr. H. J. CRUFT, Dr. C. M. MAURITZEN* and Dr. E. STEDMAN, F.R.S.

Department of Biochemistry, University of Edinburgh

THE main object of this article is to give a brief description of a difference which has been observed to exist between the histones of malignant and normal cells. For an appreciation of the nature and significance of this difference, however, a knowledge of the properties and behaviour of histones from normal cells is required. It is therefore proposed, before describing and discussing the results obtained with the histones from cancer tissue, to summarize the pertinent aspects of our knowledge of these proteins, much of which has not hitherto been published.

Basic Proteins of Cell Nuclei

It has long been known that proteins with pronounced basic properties are present in the sperm heads of many fishes as well as in the nuclei of calves' thymocytes and of nucleated erythrocytes, and more recent work has shown that such proteins are, in fact, widely distributed in the nuclei of animal, and probably also of plant, cells where they constitute a considerable proportion, in some cases amounting to 30 per cent, of the dry weight of the nucleus. Two types of such proteins have been distinguished, namely, protamines and histones, the former of which seem to occur only in the sperm heads of certain fishes. The best known and most investigated of the protamines are salmine and clupeine, the basic proteins present in the sperm heads of the salmon and herring, respectively. Their properties fully justify their separate classification on chemical grounds, for they are distinguished from the histones in three respects: their salts form true solutions in water; no aromatic amino-acids enter into their composition; and they possess considerably stronger basic properties due to a higher content of basic amino-acids. It is not certain if all the basic proteins which have been termed protamines exhibit these properties, for there is little information available about them, while some doubt remains about the purity of the specimens originally examined.

While justified on chemical grounds, the classification of the basic proteins of cell nuclei into protamines and histones is not warranted physiologically, for a study of their distribution indicates that they are homologous proteins. Thus, so far as they have been examined, all fish sperm heads contain a basic protein. In the salmon and herring this is a protamine. On the other hand, in the cod it is a histone. Taken in conjunction with the fact that

* I.C.I. Research Fellow.

basic proteins are present in all animal cell nuclei so far examined, this constitutes ample evidence of the identity of the functions of the two types of protein.

Composite Nature of Histones

The older work on histones served to demonstrate the occurrence of these proteins and to establish their general nature. With the development of methods for the isolation of cell nuclei from animal tissues additional to fish sperm and nucleated erythrocytes, the examination of an extended range of histones became possible. Such work[1,2], carried out in this laboratory, revealed the fact that the basic proteins extracted directly from isolated cell nuclei contained at least two components; one present in greater amount being provisionally termed the main histone and the other the subsidiary histone. As judged by their constancy in composition after fractionation, a number of the main histones were obtained in an apparently pure state. Purification of the subsidiary histones offered more difficulty, largely because of their occurrence in smaller amount. Nevertheless, two were fractionated to a degree approaching, although somewhat short of, purity. It has since been possible to supplement this work with electrophoretic studies both on many of the earlier preparations and on new ones obtained by identical methods. The results have confirmed and extended the former conclusions. Electrophoretic analysis indicates that, with few exceptions, the unfractionated histones extracted from isolated cell nuclei consist of three components. This is illustrated in Fig. 1, where the electrophoretic diagram obtained from the total histones extracted from the nuclei of fowls' erythrocytes is reproduced. It is proposed, following the convention in use for other proteins, to term these components, in descending order of mobility, α-, β- and γ-histones. By comparing the electrophoretic mobilities of histones from various sources with those of the fractionated preparations described in earlier investigations, it has been possible to identify the α-component with the subsidiary histones previously described. The so-called main histone consists essentially of the β-component contaminated with a small proportion of γ-component.

Cell Specificity of Histones

The species specificity of homologous proteins is such a general phenomenon that it would be expected to apply without question to the basic proteins of the cell nucleus. Nevertheless, it is difficult to demonstrate chemically such specificity if proteins of the same type are compared. Thus, salmine and clupeine, the protamines of the sperm heads of the salmon and herring respectively, are extraordinarily similar in chemical composition, although it is now known[3] that there are small differences between them, the most convincing being the presence of threonine in the latter and its absence in the former. With the recognition, however, that the histone present in the sperm head of the cod is homologous with the protamines in the sperm heads of the salmon and herring, no doubt remains that the basic proteins of nuclei from the same type of cell follow the general rule.

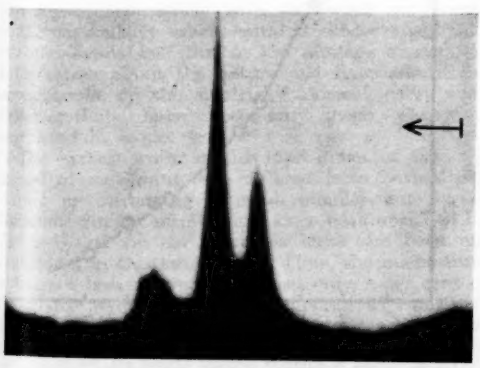


Fig. 1. Electrophoresis of total histone from fowl erythrocyte nuclei. Descending boundary; conc. 0·6 per cent; $\mu = 0{\cdot}18$; veronal buffer *p*H 7·6; showing α-, β- and γ-histones

In contrast to species specificity the cell specificity of proteins within a given organism has scarcely been discussed, no doubt because many of the proteins of the various types of cells exercise entirely different functions. But if the reasonable assumption be made that the nuclei in the different cells of the same species possess similar functions—an assumption which receives much cytogenetical and chemical justification—the question of the identity or cell specificity of the basic proteins of cell nuclei assumes considerable importance. For cell specificity in these proteins would imply that each protamine and histone was essential to, and possibly assisted in the control of, the particular character of the cell in which it occurred. That some protamines and histones are, in fact, cell specific has already been demonstrated. Thus, the nuclei of the erythrocytes and liver cells of the salmon contain histones in place of the protamine in the sperm head[3]. There is, moreover, some evidence that the histones in the two former types of cell differ considerably from one another in their arginine contents. The main histones in the erythrocytes and thymocytes of the fowl also differ demonstrably in their arginine contents, while the particular α-histone present in the erythrocytes of this species is entirely absent from the thymocytes[2]. It is true that the main histones from fowls' tissue upon which the analyses demonstrating their cell specificity were made were not homogeneous but, as indicated in the preceding section, consisted of mixtures of β- and γ-histones. This does not, however, invalidate the results, for it has since been found that the electrophoretically pure β-histones isolated from the main histones by preparative electrophoresis do not differ from the latter in their basic amino-acid contents. It is not yet certain if this absence of change in composition after purification is due to the relatively small quantity, which did not amount to more than a few per cent, of γ-component present in the main histones or to the very similar composition of the β- and γ-components, although some evidence, at present incomplete, supports the latter explanation. To illustrate the degree of purity attained by preparative electrophoresis, the electrophoretic diagram of a preparation of the β-histone from calves' thymus glands is reproduced in Fig. 2.

One impediment to the complete generalization of the above results on the cell specificity of histones has been the failure to detect any difference between the compositions of the main histones from the liver cells and thymocytes of the ox. It has now been found that these two β-histones possess different isoelectric points, which are at *p*H 11·0 and 10·8 respectively for the thymus and liver histones, and that their electrophoretic mobilities differ from one

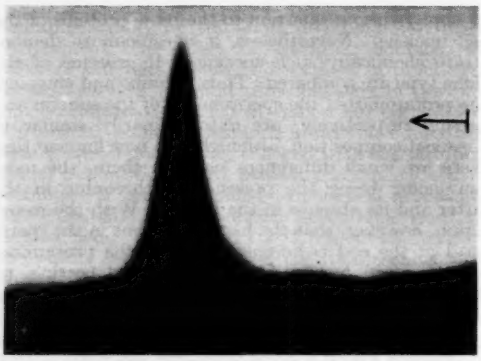


Fig. 2. Electrophoresis of pure β-histone from ox thymus nuclei. Descending boundary; conc. 0·5 per cent; $\mu = 0{\cdot}18$; veronal buffer *p*H 6·2

another over a wide range of *p*H[3]. These differences are outside the limits of experimental error. They are nevertheless so small as not, perhaps, to appear completely convincing, particularly as attempts to effect the electrophoretic separation of a mixture of the two histones gave inconclusive results. As will be described below, the cause of this failure has now been ascertained, with the result that no doubt remains that the β-histones from the liver cells and thymocytes are different substances. This achievement goes a long way to establishing as a generalization the former finding that the basic proteins of many cell nuclei are cell specific.

Aggregation of Histones

The key to the solution of the problem of unequivocally distinguishing between the liver and thymus β-histones of the ox was provided by determinations of the rates of diffusion of the two proteins. These measurements, which were made in the Hilger Tiselius electrophoresis apparatus, were primarily required for other purposes; nevertheless, it was hoped that they might also provide evidence of differences between the physical properties of the two histones. No such evidence was, however, obtained. On the contrary, the rates of diffusion of the two substances were indistinguishable at all *p*H's examined. This is evident from Fig. 3, where the diffusion constants are plotted against *p*H. While giving another example of the very great similarity which exists between the two histones and thus tending to suggest that they are identical, the curve in Fig. 3 is nevertheless remarkable in that it indicates not only that aggregation of the protein micelles takes place, but that this aggregation increases much more rapidly with increase in *p*H than is usual with other proteins. This can be better appreciated from the particle weights. When these are calculated by standard methods from the diffusion constants and the viscosities of the solutions, it is found that they increase from $7{\cdot}6 \times 10^4$ at *p*H 1·4 to 7×10^6 at *p*H 7·0. In other words, the particle weight at *p*H 7·0 is approximately 100 times that at *p*H 1·4.

Mixed Aggregates of Histones

The histones of the liver cells and thymocytes are clearly very closely related to one another. Their basic amino-acid and tyrosine contents are indistinguishable; their electrophoretic mobilities and isoelectric points differ only slightly; their particle weights in solution are, within the limits of experimental error, identical; and they possess the same pronounced capacity to form aggregates, which they do to the same degree and with the same dependence upon *p*H. This great similarity between them suggested that under appropriate conditions they might be capable of forming mixed aggregates in solution which would simulate the behaviour of a homogeneous protein. If this were the case an explanation would be offered of the failure, referred to above, to effect an unequivocal separation of a mixture of the two histones by electrophoresis in the Tiselius apparatus. The conditions used for preparing a solution of the mixture, which were identical with those employed for making the solutions for electrophoresis or diffusion experiments, were, moreover, such as to favour the formation of mixed aggregates if the molecules possessed the capacity to do this. Thus, in each type of experiment, the sulphate of the histone or histones, which itself would yield an acid solution of about *p*H 2·0 if dissolved in water, was dissolved in dilute hydrochloric acid and the solution brought to a less acid *p*H by dialysis against the appropriate buffer for a period of about three days. By this procedure the histone was changed slowly from an unaggregated or little aggregated form to that characteristic of the final *p*H of the solution. Every opportunity was thus provided for the formation of mixed aggregates when two histones were used.

With the object of submitting the above suggestion to experimental verification, it was postulated that if separate solutions of the two histones at the same *p*H and in a highly aggregated form were mixed, the formation of mixed aggregates would either not take place at all or would only do so extremely slowly. In either case, it should be possible to effect their separation from the mixture by electrophoresis. Tests of this postulate with artificial mixtures of the β-histones from ox liver and thymus glands have not only resulted in its verification but also have simultaneously conclusively demonstrated that the two histones are different compounds. This is illustrated

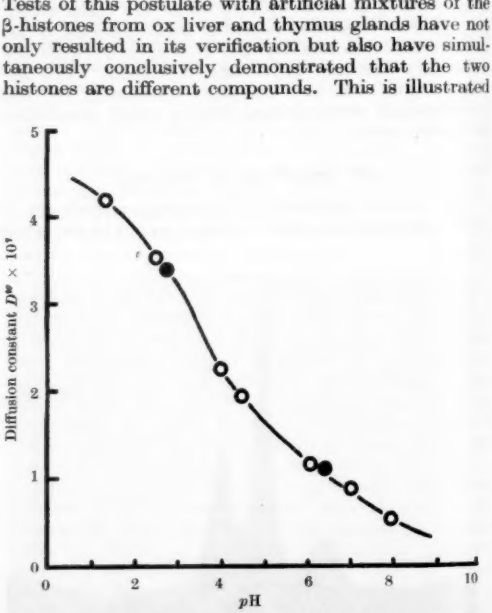


Fig. 3. Graph of diffusion constant against *p*H, for ox thymus and ox liver β-histones; conc. 0·5 per cent; $\mu = 0{\cdot}2$; veronal-HCl buffers.
Ox thymus β-histone, ○; ox liver β-histone, ●

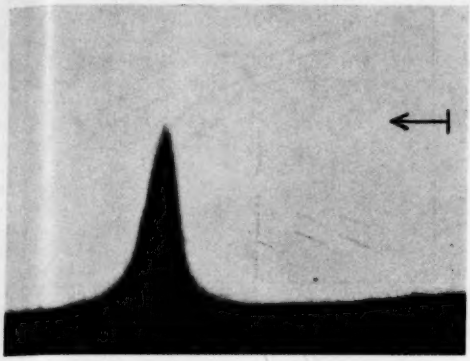


Fig. 4. Electrophoresis of an artificial mixture of ox thymus and ox liver β-histones, solution of the mixture dialysed for 60 hr.; conc. 0·6 per cent total; $\mu = 0{\cdot}18$; veronal buffer *p*H 8·6

in Figs. 4 and 5, which give electrophoresis diagrams for mixtures of liver and thymus histones dialysed together and separately at *p*H 8·7. A similar separation was obtained at *p*H 6·7. Other experiments have shown that mixed aggregates are formed with both dialysis procedures when the *p*H of the buffer is between 4·0 and 5·0. As can be seen from Fig. 3, this corresponds with the *p*H at which a rapid increase in aggregation commences. It is thus evident that below *p*H 5·0 aggregation is too small and perhaps too labile to prevent the formation of mixed aggregates on mixing solutions of the two histones.

Another example of the formation of mixed aggregates between different histones will be recorded below. Whether it is a general phenomenon among histones or whether it is confined to very closely related histones is not yet known. It is possible that it may even occur between histones and other proteins, and thus account for the power of histones to precipitate other proteins from solution.

The Histones of Malignant Cells

The investigation of the nature and properties of the components of normal cell nuclei which has been in progress in this laboratory for more than twelve years has been carried out not only for its own intrinsic interest, but also because it seemed to be a necessary preliminary to an examination of the characteristics of the nuclei of malignant cells. Some malignant cells have, nevertheless, occasionally been examined concurrently with this work on normal cells, particularly when suitable cancer tissue has become available. But in the absence of detailed information about the nature and functions of the components of the nuclei of normal cells, such investigations have necessarily been somewhat restricted in scope.

The earliest work[4] of this kind indicated that the nuclei of malignant cells differed from normal cell nuclei in containing a much smaller amount of histone. Similar results have since been obtained by Debov[5], and further examples have also been encountered in this laboratory. Thus, the nuclei from a human breast sarcoma yielded only 4 per cent of their dry weight of histone sulphate as compared with a yield of 25–30 per cent from many normal cell nuclei. Similarly, in work to be discussed below in another connexion, the nuclei from an induced rat hepatoma gave only 14·8 per cent histone sulphate. Nevertheless, such great deficiencies in histone do not appear to be characteristic of all cancer tissue, for, while high contents have never been observed in nuclei prepared from such material, figures which approach the normal value have occasionally been obtained. This was the case, for example, with a human bronchogenic carcinoma, the nuclei of which yielded 20·5 per cent of their dry weight of histone sulphate. In view of this result it appears probable that the low content of histone in the nuclei of many malignant cells is a result rather than a cause of their abnormal nature.

A new approach to the cancer problem became possible with the discovery that histones are cell specific. As an expression of the possible physiological meaning of this remarkable phenomenon, the hypothesis was advanced[1,2] that these basic proteins function in the nucleus as gene inhibitors, thus maintaining, if not wholly determining, the character of the cells in which they are present. It was implicit in this hypothesis that a change in the properties of the histone present in a cell would result in a change in its character, so that the transformation of a normal into a malignant cell would necessarily be associated with a change in the histone which it contained. Histones from both human cancers and experimental tumours have therefore been examined from this point of view.

In the first phase of the work, material accumulated by Stedman and Stedman during the course of their earlier studies was mainly used. This consisted of the β-histones obtained from the nuclei from: (1) the lymph glands in a case of human lymphatic leukæmia, (2) a human bronchogenic carcinoma, (3) a human breast sarcoma, (4) the Walker rat carcinoma, (5) the mouse carcinoma 2146, and (6) the *Rb*3 transplantable rat sarcoma induced by dibenzanthracene. All these histones were found to differ markedly from those from normal tissues in two respects. They proved to be much less soluble, and to possess considerably smaller electrophoretic mobilities than normal histones. These divergences are well illustrated by the behaviour of the histone from the case of lymphatic leukæmia. When a 0·5 per cent solution of the sulphate of this histone in dilute hydrochloric acid is dialysed against a veronal buffer above a *p*H of 4·6 for several days, a precipitate of the histone forms in the solution. The precipitation is complete at *p*H 7·0 and nearly so at *p*H 5·0. In contrast to this behaviour, histones from normal tissue such as

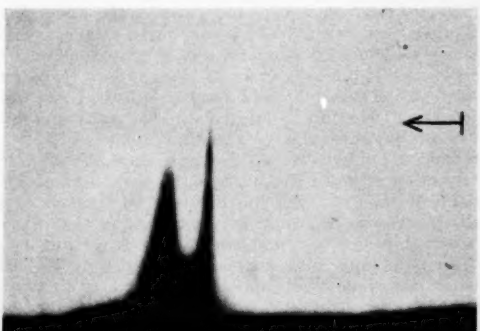


Fig. 5. Electrophoresis of an artificial mixture of ox thymus and ox liver β-histones, solution of each histone dialysed independently for 60 hr; conc. 0·3 per cent; $\mu = 0{\cdot}18$; veronal buffer *p*H 8·8. Solutions were mixed immediately prior to filling the U-tube. Complete separation

ox liver and thymus glands, fowl erythrocytes and mouse spleen and liver, exhibit no tendency to precipitate under the same conditions until a *p*H of about 10·0 is reached, that is, one approaching their isoelectric points. It is true that normal histones show an increased Tyndall effect, indicative of an increase in aggregation, with increasing alkalinity; but this effect is present in the tumour histones in much more acid solutions. The insolubility of the leukæmic histone necessarily restricts the *p*H-range over which its electrophoretic mobility can be measured. Nevertheless, in the range below *p*H 4·6, where such determinations are possible, its mobility falls with increasing *p*H very much more rapidly than is the case with normal histones. The *p*H-mobility curve appeared, in fact, to suggest that its isoelectric point is in the region of *p*H 7·0. Similar solubility and mobility effects, although sometimes somewhat less marked, were observed with the other abnormal histones[8].

The above results show that the physical properties of histones from malignant cells exhibit pronounced differences from those of normal cells. There is presumably an underlying chemical cause of these differences; but its nature has not yet been ascertained. Analytical results do not suggest that deficiencies in basic amino-acids are involved. Many features of the abnormalities could, however, be explained by an increased content of acidic amino-acids; but a further discussion of this point must await its experimental verification.

There is one respect in which the above experiments fall short of the ideal: no direct comparison was made between the histone from a malignant cell and the cell type from which it originated. It is true that, in the course of this investigation, the histone from human thymocytes has been found to exhibit a normal behaviour with respect both to solubility and electrophoretic mobility; but it might be argued that the thymocyte was of a different cell type from the lymphocyte. It was therefore deemed advisable to repair what might be regarded as a defect in this work.

For this purpose malignant hepatomas were induced in rats by the well-known method of including 3′-methyl-4-dimethylaminoazobenzene in their diets. After the tumours became palpable they were allowed to grow for 10–14 days or until the animal became moribund, whichever was the shorter period.

As the growth of the tumours had proceeded to different degrees in the individual rats, they were divided into two groups according to their weight. Those weighing between 15 and 20 gm. were termed early stage tumours, while the larger ones, weighing between 40 and 90 gm., were described as fully developed tumours. The cell nuclei were prepared separately from the two groups as well as from normal rat livers by our general methods[4], and the histones extracted from them by our normal procedure[3]. Without any purification by fractionation, all three preparations surprisingly proved to be electrophoretically homogeneous. It is certain, from their behaviour and properties, that they are not α-histones, but it is impossible at present to decide whether they are β- or γ-histones, although they are presumed to be the former.

In conformity with the behaviour of the other tumour histones, that from the fully developed rat hepatoma possessed a solubility of less than 0·5 per cent in a veronal buffer at *p*H 5·8. In other words, on dialysing a 0·5 per cent solution of the histone in dilute hydrochloric acid against the buffer, a considerable proportion of it was precipitated from the solution. On the other hand, the histone from the normal rat livers, when treated in precisely the same way, formed no precipitate, nor did it do so when the *p*H of the buffer was increased to about 8·5, the greatest alkalinity tested. The electrophoretic mobilities of the two histones, reproduced in Fig. 6, also differed, the hepatoma histone showing the rapid fall in mobility with increase in *p*H which characterized the other tumour histones. Not only do these histones differ, however, in physical properties. Quantitative determinations of their basic amino-acid contents show that they also differ significantly in their lysine and arginine contents.

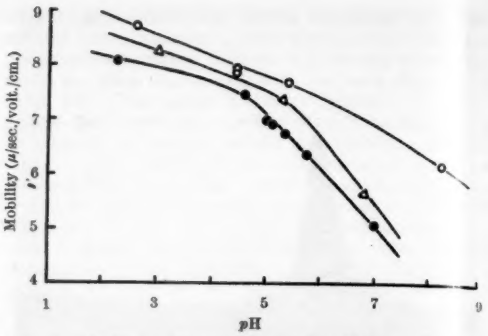


Fig. 6. Mobility – *p*H curves for rat liver histones conc. 0·1–0·5 per cent; $\mu = 0{\cdot}18$; veronal buffers. Normal rat liver histone, ○; early stage rat hepatoma histone, △; fully developed rat hepatoma histone, ●

While thus giving confirmation of the earlier results, the experiments with the rat hepatomas presented one feature which was at first puzzling. The histone from the early stage hepatoma, although electrophoretically homogeneous, exhibited properties which, as is evident from Fig. 6, were intermediate between those of the other two. In default of any better explanation, this would imply a continuous change in the properties of the histone during the growth of the tumour, despite the contradiction inherent in this implication. A better explanation can, however, be given. Although care was taken to remove normal liver tissue from the early stage tumours, this tumour tissue would undoubtedly still contain a moderate proportion of normal liver cells. As a result, the histone isolated from it would originate partly from hepatoma and partly from liver cells. If the two histones from these different cells then formed mixed aggregates in the manner demonstrated above for ox liver and thymus histones, the product would be electrophoretically homogeneous with a mobility intermediate between those of the two components. In support of this explanation it has been found that a mixture of normal rat liver histone and the histone from the fully developed hepatoma dialysed together at *p*H 5·0 or 6·8 does, in fact, simulate the electrophoretic behaviour of the histone from the early stage hepatoma. But when they are dialysed separately at *p*H 7·25, a procedure which necessarily has to be carried out at the low concentration of about 0·14 per cent for each histone, and then mixed, separation of the components occurs on electrophoresis as with the thymus and liver histones of the ox.

Two main conclusions may be drawn from the above work on malignant cells: (1) the histones

present in the nuclei of such cells are, like those of normal cells, cell specific; (2) the histones of cancer cells are characterized by solubilities and electrophoretic mobilities which are smaller than those of normal cells. These effects are associated with their greater ability, as shown by their small diffusion constants, to aggregate in solutions more acid than neutrality.

The results also support the hypothesis that histones function as gene inhibitors. It is not proposed, however, to discuss either this point or its obvious implications, for it is clear that, while the results accord with the hypothesis, they do not give final confirmation to it. But it is perhaps not out of place to point out that this work constitutes the first occasion on which a characteristic and qualitative difference has been shown to exist between a known cell component isolated from malignant cells and that obtained from normal cells.

One observation made during the course of this investigation, although it does not form part of the main theme of this article, seems of sufficient importance to be mentioned by way of a postscript. As pointed out by Miller and Miller[7], when rats are fed 3′-methyl-4-dimethylaminoazobenzene, the dye becomes bound to the liver proteins. This binding reaches a maximum in a month and thereafter slowly and continuously diminishes. In the present work, nuclei were isolated from the livers at this particular period and examined. They were found to contain dye. Nevertheless, the histone extracted from the nuclei was completely free from dye, which remained bound to the nuclear residue. If Miller and Miller's statement that deoxyribonucleic acid does not bind the dye is correct, it follows that it must be bound by chromosomin. It is thus possible that the first stage of its carcinogenic action is its attachment to the protein of the chromosomes.

We acknowledge with thanks the receipt of a grant from the Department of Health for Scotland which has defrayed part of the expense of this investigation.

[1] Stedman, E., and Stedman, E., *Nature*, **166**, 780 (1950).
[2] Stedman, E., and Stedman, E., *Phil. Trans. Roy. Soc.*, B, **235**, 565 (1951).
[3] Stedman, E., and Stedman, E., *Biochem. J.*, **38**, xxvi (1944).
[4] Stedman, E., and Stedman, E., *Nature*, **152**, 556 (1943).
[5] Debov, S. S., *Biokhimiya*, **1614**, 314 (1951).
[6] Stedman, E., and Stedman, E., *Biochem. J.*, **47**, 508 (1950).
[7] Miller, J. A., and Miller, E. C., *Adv. Cancer Research*, **1**, 339 (1953).
[8] Cruft, H. J., Ph.D. thesis, University of Edinburgh, May 1953.

OBITUARIES

Dr. H. A. Lafferty

HENRY ALOYSIUS LAFFERTY was born at Ardstraw, Co. Tyrone, on May 10, 1891. His early education took place at the local National School; at St. Columb's College, Londonderry; and at the Christian Brothers School, Omagh. He entered the Albert Agricultural College, Glasnevin, in 1908, and in the following year was awarded an agricultural scholarship into the Royal College of Science, Dublin. On receiving his diploma of the latter institution in 1912 he became a research scholar under Dr. Pethybridge, and later was appointed assistant in the Seeds and Plant Disease Division. He held this post until 1921 and was then appointed junior agricultural inspector. On Dr. Pethybridge's resignation in 1923, Lafferty became head of the Seed Testing and Economic Botany Division of the Department of Agriculture, Republic of Ireland, a post which he held until his death.

Lafferty collaborated with Pethybridge for a number of years on investigating potato diseases in the west of Ireland; but he is best known in the plant pathological world by his contributions to our knowledge of flax diseases, in investigations of which he played an important part.

During the First World War flax became an important crop, as linen was then in high demand for aeroplane construction, and foreign sources of raw material were cut off. Scarcely anything was then known about diseases of flax, and the incidence of failures, or partial failures, of this crop due to disease was common. Pethybridge appointed Lafferty to investigate this problem, and no more suitable choice could have been made. Coming from a farming community situated in the centre of a big flax-growing district, and from a family which from the early years of the nineteenth century had been engaged, first, in processing flax and later as flax buyers, Lafferty was familiar with this crop in all its cultural stages and in its preparation for spinning. This knowledge, together with his training in plant pathology, made him the ideal research worker for the job. As a result, during the period 1917–22, all the major maladies of flax in these islands were fully described and the life-history of each of the causal organisms investigated. The published reports of these researches were not only of scientific but also of economic value.

Besides the reports on investigations on flax diseases, Lafferty was joint author with Pethybridge on maladies of potato, tomato and apples, and his scientific investigations gained him the fellowship of the Royal College of Science in 1923, and afterwards the degree of D.Sc. of the National University in 1938.

As head of the Seed Testing Station from 1923 onwards, his duties left Lafferty little time for investigation of plant diseases. The knowledge of these, however, proved invaluable to him in his new post, and especially so as no plant pathologist was attached to the Seed Testing Station. Although severed from practical investigations, Lafferty never ceased to take an interest in plant pathology, and at the International Seed Testing Congress in Rome in 1928, he spoke on the importance of seed-borne diseases—an international problem which is attracting considerable attention at the present time.

He was very successful in his administration of the Dublin Seed Testing Station, and he took a personal interest in every one of his staff. Among the seed merchants he was held in the highest esteem, while the farming community will always be indebted to him for his endeavours to improve the quality of agricultural seeds sold in Ireland. Lafferty published a number of articles relative to seed testing in the *Journal* of the Department of Agriculture, Dublin, and he was a regular contributor to reports of the International Seed Testing Association.

Recognition of his work was shown by his unanimous selection as president of the International Seed Testing Association in Washington in 1950. His retention of this position each year since was a tribute to the efficiency and courtesy with which he carried out his duties. These culminated in his very successful organization of the Society's International Congress held in Dublin in May 1953.

As a debater at meetings, Lafferty had few equals and his personality was outstanding. Following a chat with him in the ordinary course of work, one always came away stimulated.

A few years ago Dr. Lafferty suffered a serious illness. Although afterwards he resumed duties, he never fully recovered his health. Then in 1953 he had a relapse, yet was again back at the Seed Testing Station in June 1954; but his return was of short duration as he soon suffered a further relapse, and he died on July 19. He was predeceased by his wife some years ago, and he is survived by two sons for whom the greatest sympathy is felt. R. McKay

Dr. W. E. Foster

Dr. W. E. Foster, who died on August 3 as a result of a motor-cycle accident, was lecturer in botany in the Durham Colleges, University of Durham. Apart from the period 1945–49, when he was an I.C.I. Fellow, he had held this appointment since 1940, when he went to Durham from King's College, Newcastle upon Tyne. He had done much work on the physiology and biochemistry of respiration, including studies of carbon dioxide zymasis; recently he had been engaged in work on physiological ecology with special reference to the oxygen supply and respiration of marsh plants. He was a gifted lecturer and an inspiring teacher; and his untimely death at the age of forty-three is deeply regretted by his many pupils, as well as by his friends and colleagues.

NEWS and VIEWS

Chemistry at Dundee : Prof. A. D. Walsh

Dr. A. D. Walsh, who is to succeed Prof. D. H. Everett (see *Nature* of March 20, 1954, p. 523) in the chair of chemistry at Queen's College, Dundee, is thirty-eight years of age and since 1949 has been successively lecturer and reader in physical chemistry in the University of Leeds. He received his undergraduate training in Cambridge, entering Corpus Christi College as an Open Scholar in 1935. His first research (with Dr. W. C. Price) was concerned with the measurement of the far ultra-violet absorption spectra of simple molecules, from which it is possible to compute their ionization potentials. More recently Dr. Walsh has greatly extended the range of his investigations in this field in a manner which has added very considerably to our knowledge of molecular structure. During the War his attention was directed to chemical processes occurring in internal combustion engines. From this work his interest naturally extended into the field of spontaneous combustion. Both in the fields of spectroscopy and of combustion Dr. Walsh has made distinctive and original contributions and, because of his capacity for lucid exposition, has been greatly in demand as a lecturer both in Britain and overseas. Although his departure is a serious loss for chemistry at Leeds, he will take with him to Dundee the good wishes of his colleagues and friends for success in his new post.

J. L. Proust (1754–1826)

One of the architects of modern chemistry, Joseph Louis Proust, was born in Angers two hundred years ago, on September 26, 1754. He began his chemical studies in his father's apothecary's shop and later became chief pharmacist to the Salpêtrière in Paris. In 1784 he made one of the first man-carrying balloon ascents with J. F. Pilâtre de Rozier, in whose *musée* he gave lectures on chemistry. From Paris he went to Spain, teaching chemistry at the artillery school in Segovia, and later at Salamanca. He served as director of the royal laboratory in Madrid during 1789–1808, when the Peninsular War ruined his career and the invading French army destroyed his laboratory and collections. It was in Madrid that his greatest and most enduring work was done. The period 1799–1807 witnessed his prolonged and bitter controversy with Jean Claude Berthollet. With brilliant analytic skill and logical reasoning, Proust pointed out some of Berthollet's errors, showed that chemical combination occurs only in fixed proportions by weight, and thereby established the law of definite chemical proportions. In 1805 he demonstrated the presence of dextrose in various natural products, and he discovered leucine in 1819. Receiving a pension from Louis XVIII, he retired to Craon in Mayenne, was elected to the Paris Academy of Sciences in 1816, and finally returned to the town of his birth, where he died on July 5, 1826, aged seventy-two.

Fire and the Atom Bomb

Fire Research Bulletin No. 1, entitled "Fire and the Atomic Bomb", by D. I. Lawson (pp. 30. London: H.M.S.O., 1954; 2*s*. 6*d*. net), deals specifically with the starting of fires by an atomic explosion and is based on a series of lectures arranged by the Home Office in May 1952 for senior fire officers and senior members of civil defence organizations. The report is written in a semi-popular style, and detailed analyses are omitted with the expressed hope that the report will be technically within the reach of a wide circle of readers. Nevertheless, it is not for the layman, and furthermore, since it is based on the official information contained in "The Effect of Atomic Weapons" (U.S. Department of Defense and U.S. Atomic Energy Commission: McGraw-Hill Book Co., 1950) and thus only on the very earliest of atom bombs, it will lose much of its interest even for those qualified to understand its details. The governing principle, as expected, is not to try to prevent all fires as a result of an atomic explosion, but to aim at reducing the fire danger to a minimum. It is important, therefore, to realize that about one-third of the energy of the bomb is released as heat radiation and that the fire danger occurs in the second flash period lasting for about three seconds, during which the bomb gives off an amount of heat equivalent to approximately 7×10^{12} calories. Accordingly, the first half of the report discusses in some detail radiation as a mode of heat transfer, the ignition of materials by an atomic flash and the physiological effect of heat radiation. In the latter half, concerned with fire prevention, attention is directed to fires started by radiation coming through windows. First, inflammable materials inside a room must be kept outside the danger zone and, secondly, the heat radiation must be prevented as far as possible from entering the room by, for example, fixing some incombustible board across the window space. Any board opaque to light radiation will also form a barrier to the heat, and various means of cutting off the radiation without obscuring the daylight are mentioned.

Formation of Plates of Grey Tin

In a brief communication to the *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* (**57**, 79, Jan./Feb.; 1954), L. J. Groen and W. G. Burgers report an important development in that they have been successful in obtaining the first compact pieces of grey tin, about 1 mm. thick and with a surface area of about 25 sq. mm. Previously, grey tin has been obtained only in powder form. From their experiments, the authors judge that the essential conditions for the preparation of the compact form are the use of thin sheets of white tin from which the grey tin is formed, a slow rate of transition and the growth of only one grey tin nucleus. The thin sheets enable the grey tin to extend in volume without splitting too soon under the stresses due to its extension; slow growth, attained by cooling to − 8° C. instead of the usual − 50° C., and starting at one point in the white tin favour a uniform formation of the grey phase. The purity of the white tin used, which in the authors' case was not less than 99·99 per cent, also has an influence. Compact pieces of grey tin were obtained starting with both polycrystalline material and with single crystals. In one instance, starting from a single crystal, a grey single crystal was formed, and a Laue transmission photograph of this single crystal is given in the report.

"Philips Serving Science and Industry"

The technical reports of Philips Industries, Ltd., are well known to the scientific world for the publication of original scientific papers of high merit and often of considerable importance. The series, now terminated, on "Electronic Measuring Instruments", which described new Philips instruments and their applications, was not, however, so well known. A new series has recently been started, known as "Philips Serving Science and Industry" (**1**, No. 1; 1954. Pp. 32; Eindhoven: N. V. Philips' Gloeilampenfabrieken. 25*s.* per volume of six numbers), and this, as its title implies, has broader terms of reference. In addition to the instrumentation covered by its predecessor, it is designed to deal generally with the engineering and other technological developments of the company and is to be issued monthly by the Industrial Products Division. The first number contains articles on dielectric heating in woodwork fabrication and on a rectifier installation in the water purification plant for Rotterdam; in addition there are contributions on instruments, which comprise vibration recorders, oscilloscopes and the 75-kV. electron microscope. The articles are technical, but the treatment is elementary so that the non-specialist will find the material easy to read and understand.

Impregnation of Small Friable Objects

In the *Museums Journal* for August, Mr. E. Martin Burgess, of the Department of Egyptology, University College, London, describes an inexpensive vacuum tank for impregnating small friable objects. Up to the present, the method has only been used with polyvinyl acetate dissolved in toluene; but it could probably be used with as good results with 'Bedacryl' or other similar strengtheners. Polyvinyl acetate solution may be painted or sprayed on objects; but the solutions must be weak to achieve sufficient penetration. This tends to produce an undesirable glossy surface, and although this may be removed by toluene, a weakening of the surface of the object results. Total immersion produced better results; but it was still doubtful whether full impregnation had been achieved. The only really satisfactory method is to place the object in a sealed chamber containing the strengthening solution and to pump out the air. For this purpose a vacuum desiccator can be used and evacuated with a water pump if some form of trap is placed between the pump and desiccator to prevent water from getting into the solution on release of the vacuum.

Books on Agriculture and Horticulture

The third edition of "Books on Agriculture and Horticulture" has recently been published (H.M.S.O. Bull. 78. 3*s.* net). Though, according to the subtitle, this list is "Selected" (and compilers of select lists will always meet their critics), it is misleading, for no matter how concise or how comprehensive a book-list aims at being, there is no excuse for including books which can be shown to be out of print, or excluding definitely acknowledged texts. This list errs in both ways. Far too many out-of-print books are included, though since some of them may be available in libraries their appearance in such a list as this may be justified; but not when other more up-to-date books are omitted. The books are also classified according to subject; even here it is difficult in certain cases to see on what basis the compiler fits a book into a certain section. Since this list is "prepared by the Ministry of Agriculture and Fisheries" it carries the weight of authority; the compiler should therefore have taken care to ensure that his selection is at least up to date. Inquiries from publishers would have given all the information required for sifting and selecting.

A Game Reserve

The reasons why the Mijeti area in the north-west corner of the Chikwawa district of Nyasaland has been chosen as a possible game reserve by the Fauna Preservation Society of Nyasaland are explained in the latest issue of *Oryx* (**2**, No. 5; August 1954). The country is rough and wild and has both advantages and disadvantages. One disadvantage is that it would be difficult to attract visitors since they would be unable to see the animals, even when it becomes possible to construct roads through the area. A great advantage is that the area now affords considerable protection from poaching. The main difficulty, however, is to keep the many active animals within the area because of the lack of water during years of poor rainfall. In 1950 the Fauna Preservation Society of Nyasaland approached the Government to see if Mijeti could be declared a game reserve. The shortage of water was admitted to be a serious difficulty, and the Government would only agree to give the Mijeti the status of a non-shooting area, until it could be proved that the game could be kept all the year round within its boundaries. Faced with this challenge, the Nyasaland Fauna Preservation Society decided to do everything within its powers to meet the demand for water, and funds were voted from meagre resources for the building of dams and otherwise improving supplies. Some of these dams have already been constructed and are serving their purpose; more are to be built during the coming dry season.

Welwitschia mirabilis

In a brief but factually rich paper entitled "*Welwitschia mirabilis* Hook. F. from Seed to Seed in the Botanic Garden of the University of Stellenbosch,

C.P.", H. Herre has given new and interesting information concerning this remarkable plant (*J. South Afric. Bot.*, 22, I, 23; 1954). In and near Angola, where the species occurs, it is stated that plants are not at all rare; also, farther to the north, plants are to be found growing freely among grasses and small bushes and are not necessarily confined to desert-like areas. H. Herre states that the local inhabitants use the dry parts of the leaves for fire-making and the bigger stems as chairs. The plants typically grow in old river beds and may develop very extensive root systems, up to 60 ft. long. Young plants apparently depend on mists for their main supply of moisture. The plants are exceedingly slow in their growth and it is estimated that very large specimens, with a stem diameter of 10–15 ft., may well be as much as a thousand years old. Some twenty-five years ago seeds were first germinated in the Stellenbosch Botanic Garden. It was observed that seedlings, immediately on germination, form a long tap-root and two cotyledons. The cotyledons are followed by two leaves; these persist throughout the life of the plant and are, in fact, the only leaves the plant ever has. They wear away at the tips and are constantly renewed by growth at the leaf-base. The flowers, which are dioecious, are produced annually. Under Stellenbosch conditions, twenty-three years elapsed before the first (female) flower appeared. Some details of the floral development and pollination are given, a brown bug being the agent of pollination in the plant's natural habitat. The paper is illustrated by some good photographs.

Vegetative Proliferation in Grass Spikelets

The proliferation of spikelets in grasses other than those races which are habitually viviparous, and the factors which induce proliferation under experimental conditions in *Cynosurus cristatus* and other species, have been discussed by P. R. Wycherley (*Ann. Bot.*, N.S., 18, Jan. 1954). It is concluded that the evidence favours the hypothesis that in the viviparous races a considerably greater minimal concentration of the putative flowering hormone is required for flower induction than for culm initiation, whereas in the seminiferous races this difference is not so great. In the viviparous races, the threshold for flower initiation is rarely exceeded so that perfect flowers appear only occasionally, while in the normally seminiferous races the conditions arise only rarely where an amount of hormone is produced sufficient to initiate culms but insufficient to promote flowering.

Fuel Research Board: Report for 1953

In these days when public attention is being focused from many directions on questions relating to fuel, its use and misuse, the report for 1953 of the Fuel Research Board with the report of the Director of Fuel Research (pp. 68+4 plates. London: H.M.S.O., 1954; 2*s.* 6*d.* net) is particularly opportune. One of the fields of misuse became the subject of public attention as the result of the persistent and highly polluted fog experienced in London in December 1952, and as a result the Government instituted a special inquiry into the broad aspects of the problem of atmospheric pollution and the preventive measures necessary to abate its effects on health and property. (No. 95 of "Reports on Public Health and Medical Subjects", which deals with the great fog of December 1952, has now been published; pp. 61 (London: H.M.S.O., 1954); 2*s.* 6*d.* net.) In the report of the Fuel Research Board will be found many references to the nation-wide surveys of pollution and to the research work which has been prosecuted by the Board for some time into the problems involved. It is opportune, too, that there should be recognition that these matters have not been neglected, and that, in addition, the problem is associated with the work of many other organizations—indeed, with the daily work of almost everyone who is concerned technically with the use of fuel of any type. Most interesting is the statement that the work on the programme of domestic heating has become intensified, for nearly one-half of the pollution by smoke arises from the use of coal in household grates, and this aspect of smoke pollution involves the most difficult problems in the application of preventive measures. Many other fields of fuel research are dealt with in the report, including work on the chemical and physical examination of coal, carbonization, gasification, the synthesis of oil and chemicals from coal, fuel oils, boilers and steam-raising, and the combustion in the coal-fired gas turbine; indeed, the multitude of activities must involve considerable co-ordination with other more specialized organizations also dealing with these aspects of fuel research.

Bibliography of Colour Television

The Television Society has recently published a most useful "Bibliography of Colour Television" (pp. 16; from the Television Society, 164 Shaftesbury Avenue, London, W.C.2; 1954; 2*s.* 6*d.* post free), which was prepared in November 1953 by Mrs. K. Bourton, librarian of Ultra Electric, Ltd., and circulated among members of the radio industry. The bibliography is divided into two sections: optical and electrical. The former starts with a reference to a paper by J. Clerk Maxwell, "On the Theory of Compound Colours and their Relation to the Colours of the Spectrum" (*Phil. Trans. Roy. Soc.*, 1860), and continues with sixty-eight references to papers and books published up to 1952. The electrical section contains 313 references to papers and books, arranged in chronological order from 1934 to 1954. A list of abbreviations used and an alphabetical list of authors are included. This brochure should prove most useful to all those engaged in the science and future development of colour television.

Fourteenth Congress of Pure and Applied Chemistry, Zurich

The Fourteenth International Congress of Pure and Applied Chemistry will be held in Zurich during July 20–28, 1955, under the presidency of Prof. P. Karrer (Zurich). At the same time, during July 21–27, the opportunity will be taken to hold the Eighteenth Conference of the International Union of Pure and Applied Chemistry, under the presidency of Prof. A. Tiselius (Uppsala). Further information regarding the Conference can be obtained from Prof. R. Delaby, 4 Avénue de l'Observatoire, Paris 6e. The Congress will be concerned exclusively with pure and applied organic chemistry and has been provisionally subdivided into three main sections: theoretical and physical organic chemistry (molecular structure, stereochemistry and reaction mechanisms); natural products (aliphatic and alicyclic compounds, including terpenes and steroids, carbohydrates, amino-acids, aromatic and heterocyclic compounds, alkaloids and glycosides); and synthetic, industrial and analytical organic chemistry (dyestuffs, plastics, tanning agents, synthetic resins, and synthetic and analytical

methods). Those wishing to read papers (10–20 min. duration) must send a short summary before February 1955. All inquiries relative to the Congress should be directed to the Secretary-General, XIVth International Congress of Pure and Applied Chemistry, Zurich 1.

Autoradiography Course at Harwell

A SPECIAL course on autoradiographic techniques will be held in the Isotope School, Harwell, during December 13–16 under the direction of Dr. S. R. Pelc, of Hammersmith Hospital, London. Lectures will be given on the theory of the photographic process; photographic action of electrons; estimation of radiation damage; calculation of concentration of tracer necessary to produce autoradiographs; biological results of investigations using autoradiographic techniques; and design of autoradiographic experiments. Demonstrations will include the squashing technique applied to bean roots grown in phosphorus-32; stripping film technique; autoradiography using stripping film technique; and use of phase-contrast microscope. Practical work will include squash preparations for autoradiography, for example, bean root; autographs of sectioned material using stripping film technique; and processing and staining of autoradiographs using normal and phase-contrast microscopes. The fee for the course is £8. Accommodation in local inns can be arranged if required. Applications should be made to the Isotope School, A.E.R.E., Harwell, near Didcot, Berkshire.

Water Pollution Research Laboratory: New Premises

ON October 1 the Water Pollution Research Laboratory will move from its temporary premises in Watford, Birmingham and elsewhere to a new permanent building in Elder Way, Stevenage, Herts; it is not likely that an official opening will take place before the spring. The new premises include a three-story block, containing administrative offices, an information section and microbiological, chemical and physical laboratories. There are also four pilot-scale laboratories and facilities for building larger experimental plant in the open. Special facilities have been provided for experimental work on the treatment of sewage and industrial wastes, including a radiochemical section which will be concerned at first particularly with problems of disposing of radioactive liquids. Two of the pilot laboratories are designed for experiments on the effect of pollution on fish; this work is carried out in collaboration with a team of biologists of the Ministry of Agriculture and Fisheries.

The Night Sky in October

FULL moon occurs on Oct. 12d. 05h. 10m., U.T., and new moon on Oct. 26d. 17h. 47m. The following conjunctions with the moon take place: Oct. 5d. 24h., Mars 4° S.; Oct. 19d. 04h., Jupiter 2° N.; Oct. 26d. 23h., Venus 3° S. In addition to these conjunctions with the moon, Jupiter is in conjunction with Uranus on Oct. 8d. 04h., Jupiter being 0·4° S.; Mercury is in conjunction with Saturn on Oct. 9d. 11h., Mercury 5·6° S., and again on Oct. 24d. 11h. when Mercury is 4·7° S. Mercury, an evening star throughout most of the month, sets too soon after the sun to be observed. Venus sets about forty minutes after sunset at the beginning and middle of the month and about the time of sunset at the end of the month, and will not be favourably placed for observation. Mars, an evening star, sets about 22h. 10m. during the month, but it lies rather low for good observation in the British Isles. Jupiter rises at 23h. 20m., 22h. 35m. and 21h. 40m. at the beginning, middle and end of the month, respectively, and will be conspicuous in the constellation Cancer, its stellar magnitude varying from −1·7 to −1·8. Saturn sets at 18h. 45m. and 17h. 55m. on October 1 and 15, respectively, and is in conjunction with the sun early in November; throughout most of the month it is unfavourably placed for observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Oct. 15d. 01h. 40·8m., 33 Taur. (*R*); Oct. 15d. 23h. 35·7m., 99 Taur. (*R*); Oct. 16d. 04h. 45·5m., 103 Taur. (*R*); *R* refers to reappearance. The Orionid meteor shower attains its maximum about October 20–23; the radiant of this shower is close to γ Geminorum.

Announcements

WE regret to announce the death of Dr. André Donatien, *correspondant* for the Rural Economy Section of the Paris Academy of Sciences and *chef de service* of the Pasteur Institute of Algeria, on August 10, aged sixty-four.

MR. H. S. TASKER has been elected a Fellow of the Institute of Metals, in recognition of his distinguished services to the Institute; the total number of Fellows is limited to twelve. Mr. Tasker was president of the Institute during 1950–51, and has been chairman of its Finance and General Purposes Committee (1940–44) and honorary treasurer (1945–47).

THE French Metallurgical Society will, as in former years, hold its "Journées Métallurgiques d'Automne" in Paris during October 25–30. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

THE dates of the meeting of the Meteorologische Gesellschaft in Hamburg, to be held in Hamburg in honour of the centenary of the birth of G. Hellmann (see *Nature*, May 15, p. 896), have been changed to October 8–11.

THE Swiss Federal Commission for studying Hail Formation and Hail Prevention will hold an international symposium on experimental meteorology at the Swiss Federal Institute of Technology, Zurich, during October 4–6. The symposium will discuss primarily the question of the natural processes of rain and the methods of influencing it, as well as the problem of the formation of hail and its possible prevention. Further information can be obtained from the president of the Commission, Prof. R. Sänger, E.T.H., Postfach, Zurich 23.

ISSUED annually, with some interruptions, since 1915, the "Subject Index to Periodicals" is now being published quarterly with annual cumulations. The first of these quarterly issues covers January to March 1954 (pp. 71. London: Library Association), and the three hundred British periodicals indexed have been carefully selected to meet the needs of the smaller as well as the larger public library, and those of academic and special libraries. How far the greater frequency of publication enables the "Index" to keep pace more closely with the influx of material cannot fairly be judged from a single issue, and the full advantage will probably be derived in the annual cumulation.

THE BULGARIAN ACADEMY OF SCIENCES

By Dr. D. R. NEWTH

Department of Zoology, University College, London

ALTHOUGH it can be said to have its origins in the foundation, in 1869 at Braila in Rumania, of the Bulgarian Literary Society, the Bulgarian Academy of Sciences did not become a model of the traditional European academy until much later. The Literary Society moved to Sofia in 1878 after Bulgaria's liberation from Turkish rule; but it was not until 1911 that the intentions of its founders were realized and it became, in fact and in name, an Academy of Sciences. From then until 1944 it remained a body of scholars, with the publication of learned periodicals and the holding of scientific meetings as its main functions.

Plans for the extension of the work and responsibilities of the Academy were discussed between 1944 and 1947, and its present form was determined by a law passed in 1947 and a decree issued in 1949. These have turned the Academy into a body controlling the activities of a number of research institutes and exercising quasi-ministerial authority over a great deal of Bulgarian science. At present its work is carried on by seven sections, each with several institutes. These are: (1) Physics, Mathematics and Technology (with three institutes); (2) Geology, Geography and Chemistry (with three institutes); (3) Biology and Medicine (with twelve institutes); (4) History, Archæology and Philosophy (with seven institutes); (5) Law and Economics (with two institutes); (6) Linguistics, Ethnography and Literature (with three institutes); (7) *Beaux arts* (with three institutes). In the near future the section of Biology and Medicine is to be divided into two, a new section of Agrobiology with five institutes and a section of Medical Science with seven.

Not all these institutes are primarily research organizations. Thus the Zoological Gardens in Sofia and the Ethnographic Museum have the status of Academy institutes. In establishing new institutes it has been the policy of the Academy to proceed with some caution. Where the case for a new institute is held to have been made, it is started with a small nucleus of workers, perhaps as few as three, and probably not in quarters of its own. It is then allowed to grow, and if its work flourishes it will be given buildings designed for it, some years after its inception. Most of the fully fledged institutes have between fifteen and twenty scientific workers headed by a director (normally, but not always, an academician) and controlled by a council upon which are represented the sectional committee of the Academy, appropriate Ministries and the heads of the institute's research teams. Such institutes may publish an annual bulletin of researches; thus the Biological Institute (until his recent death directed by Prof. M. Popov) has just issued its fifth, while the younger Institute of Morphology, under Prof. Hadjiolov, has just published its first.

The bulletins and the other publications of the Academy are well produced and the use of French and German, and to a lesser extent English, is common.

The Academy is also represented at the conferences which plan the work of institutes other than its own, and through its Presidium, Council of Co-ordination and planning commissions is coming more and more to co-ordinate the scientific life of the whole country. University departments do not come under the Academy or receive grants from it; but university teachers may use the facilities of Academy institutes for researches that can best be carried on in them.

At the present time there are forty-eight academicians, forty-six corresponding members and approximately five hundred full-time qualified workers in the Academy's institutes.

The Academy is conscious of the fact that during its re-organization it has not paid as much attention as is desirable to developing working relations with scientists abroad, and particularly with those of the West. It hopes next year to take a first step in improving its international contacts by inviting numbers of foreign scientists to visit it.

INSTITUTE OF CHEMISTRY OF IRELAND

SUMMER SCHOOL IN ORGANIC CHEMISTRY

THE Institute of Chemistry of Ireland held its first summer school during July 6–9 in University College, Dublin, the school being a refresher course on organic chemistry, with ninety-four participants. In his opening address, the president of the Institute, Prof. T. P. Dillon, of University College, Galway, stressed the necessity for chemists during their careers to return to the university at intervals to obtain some knowledge of advances made in fields of chemistry outside their special interest.

A series of four lectures on stereochemistry was given by Prof. T. S. Wheeler, professor of chemistry, University College, Dublin. He showed how hybridization of s and p orbitals gives the shapes of the methane, ethylene and acetylene molecules. He described how sp^2 hybridization is involved in the Walden inversion and explained how the original Mills–Nixon theory was no longer applicable. In treating of the stereochemistry of tetrahedral carbon, he discussed the necessary and sufficient conditions for molecular dissymmetry. Fisher's system of projection and his ideas as regards relative configurations were explained. Rosanoff's glyceraldehyde standard and the manner in which it is related to the serine standard by the Ingold school were described. After a discussion of absolute configuration, the stereochemistry of *cyclo*hexane and the decalins was demonstrated by means of models, and the application of conformational analysis to steroids was shown. In his closing address, Prof. Wheeler outlined recent work on the absolute configuration of natural products such as the steroids. The fluorescent glass models of *cyclo*hexane, decalin and steroid systems made by Mr. W. Brady, of University College, Dublin, were greatly appreciated.

In two lectures Prof. Wesley Cocker, University professor of chemistry, Trinity College, Dublin, dealt with new reagents and techniques. He criticized the old idea that the aldehyde–Girard products are more stable than the ketonic adducts and went on to describe newer methods for isolating carbonyl compounds. He then described modern specific catalysts for reducing alkene and carbonyl compounds. Recent oxidizing agents which are specific for various groups were outlined, and in conclusion the work of Linstead and others who have produced long-chain fatty acids by a variation of the Kobe electrolytic synthesis of paraffins was described.

In the two hours allotted to him, Mr. P. W. D. Mitchell, Lasdon Fellow of the Medical Research Council of Ireland, described briefly the symbols and terminology used in absorption spectroscopy. He indicated how the positions of the regions of absorption and the intensity might be correlated empirically with the nature and distribution of chromophores and auxochromes in the molecule and then described some work in which he is engaged for the Medical Research Council of Ireland. In this work the ultraviolet absorption spectra are used as a means of determining molecular weights and also as a method for the identification of sugar osazones.

Dr. E. F. McCarthy, senior Fellow of the Medical Research Council of Ireland, outlined recent advances in electrophoretic technique and its application to the separation of high- and low-molecular-weight substances of biological importance. He discussed the relative merits of boundary and zone electrophoresis with reference to his own work on the identification of blood proteins. Dr. McCarthy also described the more recent refinements in the estimation of molecular weights by osmotic pressure measurements.

Two lectures on "Distillation" were delivered by Mr. F. T. Riley, lecturer in chemistry in University College, Dublin, dealing with liquid–vapour equilibria and with the theoretical basis of modern laboratory fractional distillation. Laboratory fractionation practice in the 1920's was contrasted with present-day methods. Mr. Riley emphasized the changes brought about by the introduction of controlled reflux, and packed columns. He then reviewed the factors influencing separation efficiency and described the high-efficiency column working in the Department of Chemistry of University College, Dublin. This column has a packed length of 9 ft., and its performance is equivalent to that of a column containing at least two hundred theoretical plates. A feature of this column is the intermittent vapour draw-off device which is useful with an azeotropic mixture that separates on condensation.

Prof. F. J. Coll, professor of chemistry in University College, Galway, gave two lectures on "Chromatography" and discussed this technique under the following headings: absorption chromatography, partition chromatography, paper chromatography, ion-exchange chromatography and electrochromatography. Many excellent paper chromatograms of sugars, prepared by Prof. Coll, were used for illustrating the points described. Other experimental demonstrations were much admired.

Two lectures on organic chemistry and analysis were given by Dr. Cecil L. Wilson, reader in analytical chemistry in The Queen's University, Belfast. Beginning with a review of the development of analytical chemistry, he went on to discuss the use of micro-methods in the laboratory. He described the application of organic reagents in gravimetric, titrimetric and colorimetric procedures and showed how the requirements for a 'classical' organic reagent have been modified by the addition to this class of the 'complexones', which cannot be regarded as following the accepted pattern. The inorganic analyst, in particular, is bound, in the future, to take more note of the methods of his organic colleague, since he will more and more be faced with problems of compound analysis rather than of ion analysis.

Mr. C. D. O'Briain, Department of Chemistry, University College, Dublin, organized an excellent display of scientific apparatus, the material being supplied by a number of manufacturers and agents.

EVA M. PHILBIN

PHYSICS IN ISRAEL

THE seventy-fifth birthday of Prof. Albert Einstein was celebrated in Israel by a scientific convocation which was held on March 14 in Jerusalem, under the joint auspices of the Hebrew University of Jerusalem; the Technion, Haifa; the Weizmann Institute of Science, Rehovot; and the Research Council of Israel. Tributes were paid to Prof. Einstein by Mr. Y. Ben-Zvi, the Israeli president, Mr. M. Sharett, the Israeli prime minister, and Prof. B. Mazur, president of the Hebrew University, and various aspects of Prof. Einstein's contributions to science were discussed by Prof. G. Racah of the Hebrew University (quantum theory), Prof. C. Pekeris of the Weizmann Institute (Brownian movement), Prof. N. Rosen of the Technion (relativity) and Prof. S. Sambursky, director of the Research Council (cosmology).

In addition, the March number of the *Bulletin of the Research Council of Israel* (**3**, No. 4; 1954) is dedicated "with the highest esteem and affection of the scientists of Israel" to Einstein in honour of his birthday, and contains a photograph of Prof. Einstein as frontispiece. The contents consist of twenty-four original contributions, mainly devoted to mathematics or theoretical physics, the abstracts of the papers presented at the inaugural meeting of the Israel Physical Society held during April 12–13, 1954, and six short research notes. The *Bulletin*, which is in English, contains, in addition, abstracts of the original contributions in both Hebrew and English.

The inaugural meeting of the Physical Society consisted of a general session, opened by the Society's first president, Prof. G. Racah, at which two addresses were delivered, one by E. D. Bergmann on the influence of modern physics on organic chemistry and the other by M. Chwalow on the role of physics in industry, and four other sessions devoted to general and industrial physics; theoretical physics; atomic, nuclear and molecular physics; and methods and instruments. The abstracts indicate that work in the experimental field of physics is gradually being built up alongside the numerous theoretical studies, and show that recent activities include the construction of a thin lens magnetic β-ray spectrometer, and of a Couette viscometer for precision measurement in the centipoise ranges, the measurement of the absorption and scattering of 1–3 cm. radiation by a d.c. discharge in helium and air using a low-powered klystron as microwave generator, and experiments on luminescence.

S. WEINTROUB

ONTARIO RESEARCH FOUNDATION

REPORT FOR 1953

IN the annual report for 1953 of the Ontario Research Foundation*, by the director of research, Dr. H. B. Speakman, to which is appended a list of papers published during 1953 and the financial statement, attention is directed to the increase of almost 100 per cent in the research work performed for industry and under contract for government agencies during the five years 1949–53. Income from such sources increased from 277,777 dollars to 506,189 dollars, and the Provincial grant was increased from 167,904 to 260,230 dollars, the Federal grant remaining at 25,000 dollars. Dr. Speakman urges that these grants should increase in accordance with the demands made on the Foundation. While there was no increase in administrative staff during the period under review, the scientific staff increased from fifty-one to sixty-seven and technical staff from thirty-eight to forty-six. In biochemistry, the laboratory dealing with canning problems was closed; but the fellowship on the utilization of the hulls of rice has led to the commercial production of humidifier plates from rice hull ash and to a high-temperature, light-weight insulating refractory now under study by a large manufacturer of fire-bricks in the United States. The possibility of utilizing whey with inorganic and cheap ammonium salts for the production of a yeast high in complex proteins of nutritive value in the diets of domestic animals is being explored, and considerable progress has been made in the production of tanning materials from waste sulphite liquors and the waste phenolic liquors from petroleum refineries, as well as in the development, in the oils and fats laboratory, of formulæ and methods for a butter-like spread, with good keeping properties, which can be used by the Armed Services under a wide range of climatic conditions.

In chemistry the Air Pollution Laboratory is making a systematic study of atmospheric conditions in the Sarnia area, in which several refineries and chemical plants are operating, under varying climatic conditions, and similar surveys are in progress in Maitland and Millhaven. The Electroplating Laboratory made important progress in studies of the influence of the physical metallurgy and mechanical processing of the basic metal on the subsequent electroplating process. Encouraging results have been obtained with a tanning agent prepared by the Organic Section from lignin, and similar compounds are being tested as dispersing agents, while a similar product has shown promise as a relatively cheap thermo-setting resin with water-repellent properties for use in the manufacture of boards from sawdust and other wood waste.

The Department of Engineering and Metallurgy, which is still in urgent need of more space and facilities, has continued its fundamental work in physical metallurgy, and investigations in ferrous metallurgy have been extended to include the pre-treatment and concentration of ores to provide concentrates for the basic process. The hypothesis that changes in the lay-length of a wire rope in service may provide reliable indications of weakness and ultimate failure has received considerable support from results obtained on experimental machines. The Department of Research Services continued to increase its contacts with industry and also the number of repeat requests for service.

In the Department of Parasitology more attention was given to basic research. Work on the tapeworms occurring in carnivorous animals, especially foxes, continued, that on a hydatid disease in moose and wolves was concluded, and the life-history of the bot fly which lives parasitically in chipmunks has been determined. The survey of the Algonquin plain by the Department of Physiography was carried forward from Espanola to Saulte Ste. Marie, but the mineralogical study of soils in southern Ontario was temporarily halted. An ecological study of the growth of soybeans in southern Ontario and the adjoining States of the United States has been started.

In the Textiles Laboratory the emphasis has passed to problems connected with product development, including fabrics for wearing apparel, household furnishings and industry. Pressing temperature studies of the maximum temperature to which fabrics may be submitted have included a comparative study of viscose and acetate rayon, cotton, linen, nylon and orlon. Under the Nylon Fellowship of Canadian Industries, Ltd., a study of available methods and instruments for measuring resistance to abrasion supports the view that abrasion resistance and wear cannot be correlated with confidence. The influence of chemicals and temperature on the tensile strength and bursting strength of filter cloths was being investigated, and apparatus and experimental techniques were being developed to investigate the influence of cloth construction on the efficiency of a filter press.

* Ontario Research Foundation. Annual Report, 1953. Pp. 32. (Toronto: Ontario Research Association, 1954.)

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1953

THE report for 1953 of the British Electrical and Allied Industries Research Association*, the thirty-third year of its operation, records, in addition to summarizing the results of the year's work, the inception of an important new development. This is the commencement of the erection at Leatherhead of buildings which will ultimately completely re-house the Association's laboratories, at present situated at Perivale. The cost of this project, amounting to some £400,000, will be met for the most part by special capital contributions from the members, together with a grant from the Department of Scientific and Industrial Research which will probably amount to £100,000.

The main fields of activity of the Association necessarily form a fairly stable pattern over a period of years. Work on high-power switch gear and on dielectric materials have long occupied prominent places in the research programme, and continue to do so. Both these branches illustrate a feature which is characteristic of much of the work of the Association, namely, that the investigation of problems of direct

* British Electrical and Allied Industries Research Association. Thirty-third Annual Report—1st January, 1953, to 31st December, 1953. Pp. 160. (Leatherhead: The Association, 1954.)

technological importance often stimulates investigations of a fundamental character and produces new knowledge in the field of pure science. Experimental and theoretical researches are being pursued into the fundamentals of arcing phenomena and into the breakdown processes of discharges in gases and in solid dielectrics where the breakdown is occasioned by internal discharges. Work on the general theory of electrons in solids has produced a canonical transformation which can be applied to the movement of slow electrons in ionic crystals and which permits an estimate to be made of the energy and mass of 'polarons', that is, electrons carrying some ionic displacements with them.

The work on surge phenomena has been concerned mainly with surges on systems and in transformers. Surges on transmission lines arising from lightning have been recorded on equipment installed for that purpose, and analyses have been made of large numbers of fault reports from the British Electricity Authority and area boards. It is noted, however, that the incidence of thunderstorms during the year under review was abnormally low, and in the London area two hundred magnetic link lightning detectors did not record a single disturbance. In the field of transmission and distribution the Association has continued its work on the continuous and short-circuit rating of power cables and has begun to extend these investigations to higher frequencies, in the first instance to 400 c./s.

In connexion with the research on generation by wind power which has been in progress for some time, the Association has carried out a wind-power survey of the British Isles and it is stated that this is now practically complete. A gust recorder installed at Costa Hill in Orkney, where there is a 100-kW. wind-power generator in operation, recorded during the gales at the end of January 1953 gust velocities of 125 m.p.h.

Under the Power Plant Section, work continues on the creep and corrosion resistance of steels at high temperatures, on condenser tubes, and on the properties of high pressure – high temperature steam. It is noted that a detailed study of the creep and tensile properties of a large molybdenum – vanadium steel turbine-rotor forging is in progress and is well advanced.

Associated with the researches on switch and control gear are programmes of work conducted in the laboratories of the Safety in Mines Research Establishments at Buxton and at Sheffield. One of the problems under investigation is that of 'pressure piling' in flameproof motors. This is a phenomenon in which the pressure generated on explosion is greater with the machine running than with the machine stationary. Determinations are also being made of safe flange gaps for inflammable mixtures. An important allied investigation is in progress on intrinsically safe apparatus.

Among the items reported under "Unclassified Researches" is a significant improvement in the life of the hydrogen–oxygen fuel cell resulting from the development of a method of diminishing the corrosion of the oxygen electrode. In the same section it is stated that further work has been done on the 'self adjusting welding arc' and that the extension of the practical application of the surge injection principle for arc maintenance is being pursued.

It is evident from many references in the detailed sections of the report that the work which is supported by the Association in university departments throughout Britain is being actively maintained. The report concludes with a list of some forty papers and articles published by the staff during the year and about half that number of publications based on technical reports of the Association. There is a further list of translations from foreign journals and of bibliographies which have been prepared.

The report taken as a whole gives the impression that the Association is not only carrying on a large volume of research which is of direct importance to the electrical industry and to the community, but also that its policy is one of vigilant surveillance of the whole field to ensure the effective co-ordination of its work with the general body of research activity throughout the industry and in government establishments. The presentation of the individual sections of the Association's work in the report is made in a very satisfactory way; but there is little to indicate the relative scale of effort associated with each. It would add appreciably to the interest and value of the report if some indication could be given as to the relative magnitudes of the Association's various fields of activity.

PYROPHOSPHATASES IN PLANTS DURING GROWTH

By Dr. B. NAGANNA* and C. E. SRIPATHI

Dept. of Chemistry, Madras Veterinary College, Madras 7

THE occurrence of an alkaline pyrophosphatase, active only in the presence of added magnesium ions (0·02 *M*), was recently reported[1] in fresh potato extracts. Further studies have revealed its occurrence in many other plants. Unlike animal tissues[2], plant tissues show high acid pyrophosphatase activity also. With the same substrate concentration, the alkaline pyrophosphatase activity is found to be always greater than that of the acid pyrophosphatase in green leaves, whereas in seeds the reverse is observed. This unequal distribution of the two enzymes that act on the same substrate led us to consider whether any significant differences in their elaboration during plant growth could be observed which would throw some light on their specific metabolic functions.

Wheat (*Triticum vulgare*), a monocotyledon, showing more acid pyrophosphatase and less alkaline pyrophosphatase activities, and french beans (*Phaseolus vulgaris* L.), a dicotyledon, showing no alkaline pyrophosphatase but very high acid pyrophosphatase activities, were germinated on loose soil and analysed at intervals. When roots and shoots had developed, separate analyses were conducted with each part. The enzyme extracts obtained by maceration of weighed fresh tissues with ice-cold double-distilled water were centrifuged and kept in an ice-box. They were further suitably diluted (1 in 10 to 1 in 1,000) just before the assay of the enzymes. Both the acid and the alkaline pyrophosphatases and also the acid phosphatase were assayed as follows.

The incubation mixture (5 ml.) contained 0·5 ml. of the enzyme extract in each case, and 4 ml. of veronal–acetate buffer (Michaelis[3]), *p*H 5·32, and 0·5 ml. of neutralized sodium pyrophosphate (0·01 *M*) for acid pyrophosphatase, 3·9 ml. of buffer, *p*H 8·68,

* Present address: Dept. of Biochemistry, Andhra Medical College, Visakhapatnam, India.

Table 1. Acid and Alkaline Pyrophosphatases and Acid Glycerophosphatase Activities of Different Parts of Wheat Plant

Days after germination	Nature of the plant tissue	Enzyme activity in γP per min. per gm. fresh tissue		
		Acid PP-ase	Alk. PP-ase	Acid GP-ase
0	Wheat grains	390	150	95
1	"	360	96	55
2	Wheat seedling (roots 2–4 cm.; shoots 0·5–0·8 cm.)	420	175	145
4	Roots (6–10 cm.)	138	114	65
	Cotyledons	747	137	180
	Shoots (7–8 cm., with 1st leaf just protruding from the sheath)	285	714	125
	Whole seedlings*	333	390	123

* Values calculated from the weights and activities of the different parts of the seedlings.

0·1 ml. of magnesium chloride (1·0 *M*), and 0·5 ml. of unneutralized sodium pyrophosphate (0·01 *M*) for alkaline pyrophosphatase, and 4 ml. of buffer, *p*H 5·32, and 0·5 ml. of sodium-β-glycerophosphate (0·1 *M*) for acid phosphatase. The incubations were carried out at 40° C. for 10 min. in the case of the pyrophosphatases and for 20 min. in the case of phosphatase. The enzyme action was stopped by trichloracetic acid, and the liberated orthophosphate estimated by the method of Fiske and Subbarow[4]. The results are shown in Tables 1 and 2.

As these experiments were designed primarily for studying the comparative distribution of the three enzymes at different stages of plant growth, the activities are expressed as micrograms phosphorus liberated per min. by the enzyme present in 1 gm. of fresh tissue. The results with wheat show that all three enzymes are increased during germination, the increase in each being confined largely to a particular tissue. The french beans showed no alkaline pyrophosphatase activity even though the acid pyrophosphatase activity was unusually great. This high activity of the latter, exclusively confined to the cotyledons, gradually decreased with plant growth. Eight days after germination, when the primary leaves were fully developed, the acid pyrophosphatase of the cotyledons, which were very much shrunken, was reduced to about 10 per cent of the original value. These results suggest the participation of this enzyme in the catabolic processes in the cotyledons by which the reserve food materials are converted into simple metabolites suitable for utilization by the growing embryo. Further, the acid pyrophosphatase content of the green leaves is relatively high, indicating that it has a role in metabolic processes involved in the translocation of the food material in the plant. These facts explain the occurrence of large amounts of acid pyrophosphatase in vegetable tissues, whereas animal tissues contain only negligible amounts, even though both tissues contain appreciable amounts of the alkaline pyrophosphatase[2].

Table 2. Acid and Alkaline Pyrophosphatases and Acid Glycerophosphatase Activities of Different Parts of French Bean Plant

Days after germination	Nature of the plant tissue	Enzyme activity in γP per min. per gm. fresh tissue		
		Acid PP-ase	Alk. PP-ase	Acid GP-ase
0	Seeds	21,000	nil*	140
1	Cotyledons	10,130	nil*	80
	Plumules	282	363	18
2	Cotyledons	11,800	nil*	173
	Hypocotyls	575	213	280
	Plumules	492	1,010	34
3	Roots	276	164	170
	Cotyledons	8,300	nil*	294
	Hypocotyls	512	253	210
	Plumules	816	1,384	350
	Whole seedling†	5,600	50	225
4	Roots	390	186	175
	Cotyledons	7,900	nil*	340
	Hypocotyls	600	360	300
	Plumules	620	1,850	320
	Whole seedling†	5,070	163	300
8	Roots	226	98	98
	Cotyledons	2,400	nil*	240
	Hypocotyl	290	68	150
	Leaves	710	1,320	510
	Whole seedling†	600	280	215
16	Primary leaves	120	440	80
	Secondary leaves	500	780	360
36	Primary leaves	129	244	—
	Secondary leaves	180	524	—
	Other leaves	848	996	—
—	Tender pods (one week old)			
	Seeds	426	378	122
	Pulp	168	96	62
—	Mature pods (skin dried up)	16,000	nil*	160

* Activity at *p*H 8·68 was less with magnesium chloride than without.

† Values calculated from the weights and the activities of the different parts of the seedlings.

The tender pods of the french bean had both the acid and alkaline pyrophosphatases in nearly equal amounts, the alkaline pyrophosphatase disappeared as the pods matured, and at the same time the acid pyrophosphatase was tremendously increased. The former, absent in the seed, developed in the plumule even in one day after germination. It rapidly increased as the primary leaves developed. The activity of the primary leaves decreased as the secondary leaves developed, which showed high activity. The high activities of the secondary leaves also decreased when other leaves appeared. The significant elaboration of the alkaline pyrophosphatase in the growing leaves, which are the sites of intense metabolic activity, indicates the important role of this enzyme in photosynthesis. Any actively respiring tissue requires the presence of adequate amounts of coenzymes to participate in the oxido-reduction processes. Reversible enzymatic mechanisms by which two very important respiratory coenzymes, diphosphopyridine nucleotide and flavinadenine dinucleotide, could be synthesized have recently been reported[5,6]. Equivalent amounts of pyrophosphate ions are said to be formed with diphosphopyridine nucleotide (or flavinadenine dinucleotide) reversibly from adenosine triphosphate and nicotinamide mononucleotide (or riboflavin phosphate). Removal of pyrophosphate ions enzymatically would lead to a shift in the equilibrium towards formation of more nucleotide. The actual enzyme responsible for the removal of pyrophosphate ions must be the alkaline pyrophosphatase, since it acts at an alkaline *p*H, and it has an immeasurably high affinity for the substrate[2]. Its rapid elaboration in the leaves from plumules one day old onwards supports such an assumption.

It may therefore be concluded that the alkaline pyrophosphatase is associated with the anabolic processes in the leaf, while the acid pyrophosphatase participates in the catabolic processes taking place during translocation of the carbohydrates synthesized in the leaf. [May 12.

[1] Naganna, B., *Curr. Sci.*, **20**, 101 (1951).
[2] Naganna, B., D.Sc. thesis, Andhra University, Waltair (1952).
[3] Michaelis, L., *Biochem. Z.*, **234**, 139 (1931).
[4] Fiske, C. H., and Subbarow, Y., *J. Biol. Chem.*, **66**, 375 (1925).
[5] Kornberg, A., *J. Biol. Chem.*, **182**, 779 (1950).
[6] Schrecker, A. W., and Kornberg, A., *J. Biol. Chem.*, **182**, 795 (1950).

ATOMIC WEIGHTS OF THE MONOISOTOPIC ELEMENTS

By Prof. HENRY E. DUCKWORTH

Department of Physics, Hamilton College, McMaster University, Hamilton, Ontario

THE work of Aston in the measurement of isotopic abundances and masses made it possible to compute, for the first time, the chemical atomic weight from purely physical data. As a result of the development of modern mass spectrometers and mass spectrographs, the accuracy of these physically determined values has steadily improved to the point where they are now generally recognized as being more reliable than their chemically determined counterparts. This communication is concerned with the physical atomic weights of the twenty-two monoisotopic elements, and supplements a review published[1] two years ago by Scott and Bettman.

Accurate physical masses are known for seventeen of the monoisotopic elements. In the remaining five cases, namely, cæsium-133, terbium-159, thulium-169, tantalum-181 and gold-197, reliable estimates of the mass can be made in the following manner. If the points representing the stable odd-A nuclides on a graph of 'mass defects' (mass defect is difference between atomic mass of a nuclide and its mass number) be joined together, they are found to lie on a comparatively smooth curve, which shows abrupt changes in slope only at the positions of the major nuclear shells. This regularity has been demonstrated[2] for the region $30 < A < 130$ in a recent paper by Collins, Johnson and Nier. In order better to establish the position of this odd-A line in regions where few odd-A masses have been measured, as in the rare-earth region, a second curve may be drawn which is tangent to the series of curves joining the even-A isotopes of the even-Z elements. This second curve is based upon a much larger body of experimental data, and is shown in Fig. 1 as a solid line. The open circles lying above this line represent the stable odd-A nuclides in this region the masses of which are known, and they can be seen to be displaced from the solid curve by a regular amount. One can, therefore, obtain the masses of the unknown odd-A nuclides by interpolation: in no case would the error associated with such an estimate exceed 3 milli-mass-units, an amount shown in the lower right-hand corner of Fig. 1. The five interpolated values are shown on the graph as closed circles.

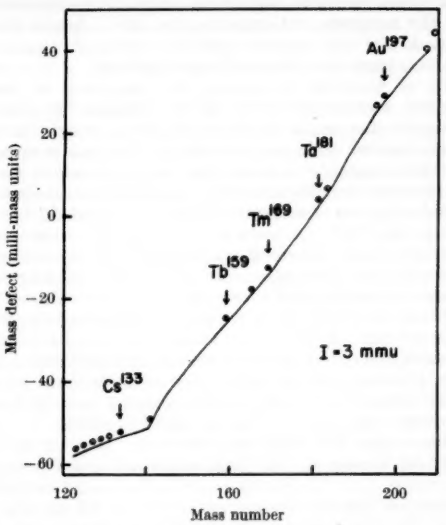


Fig. 1. Plot of mass defect versus mass number. The solid line is tangent to the curves formed by the even–even isotopes of the even-Z elements. The open circles represent odd-A nuclides the masses of which are known, while the closed circles are interpolated values for the five monoisotopic elements the masses of which have not been measured

Comparison of Physically and Chemically Determined Atomic Weights of the Monoisotopic Elements

Element	Isotopic weight	Atomic weight Physical	Atomic weight Chemical*	Source of isotopic weight quoted
Be^{9}	9·01504 ± 3	9·01253	9·013	*a*
F^{19}	19·00446 ± 2	18·99917	19·00	*a*
Na^{23}	22·99706 ± 3	22·99066	22·997	*b*
Al^{27}	26·99007 ± 3	26·98256	26·98	*b*
P^{31}	30·98355 ± 4	30·97493	30·975	*b*
Sc^{45}	44·97010 ± 5	44·95759	44·96	*c*
Mn^{55}	54·95581 ± 10	54·94052	54·93	*d*
Co^{59}	58·95157 ± 10	58·93517	58·94	*e*
As^{75}	74·94570 ± 5	74·92485	74·91	Ref. 2 and e
Y^{89}	88·9341 ± 2	88·9094	88·92	" "
Nb^{93}	92·9354 ± 1	92·9095	92·91	" "
Rh^{103}	102·9376 ± 5	102·9090	102·91	*f*
I^{127}	126·9453 ± 1	126·9100	126·91	*g*
Cs^{133}	132·948	132·911	132·91	†
Pr^{141}	140·9509 ± 4	140·9117	140·92	*h*
Tb^{159}	158·976	158·932	159·2	†
Ho^{165}	164·9822 ± 8	164·9363	164·94	*h*
Tm^{169}	168·988	168·941	169·4	†
Ta^{181}	181·004	180·954	180·88	†
Au^{197}	197·028	196·973	197·2	†
Bi^{209}	209·0446 ± 10	208·9864	209·00	*h*
Th^{232}	232·1093 ± 10	232·0447	232·12	*i*

* Taken from the 1951 Report of the Committee on Atomic Weights (Ref. 4).

† Estimated from Fig. 1.

a, Li, C. W., Whaling, W., Fowler, W. A., and Lauritsen, C. C., *Phys. Rev.*, **83**, 512 (1951).
b, Li, C. W., *Phys. Rev.*, **88** 1038 (1952).
c, Collins, T. L., Nier, A. O., and Johnson, jun., W. H., *Phys. Rev.*, **84**, 717 (1951).
d, Collins, T. L., Nier, A. O., and Johnson, jun., W. H., *Phys. Rev.*, **86**, 408 (1952).
e, Hogg, B. G., and Duckworth, H. E., *Can. J. Phys.*, **31**, 942 (1953).
f, Hogg, B. G., and Duckworth, H. E., *Can. J. Phys.*, **30**, 637 (1952).
g, Halsted, R. E. *Phys. Rev.*, **88**, 666 (1952).
h, Hogg, B. G., and Duckworth, H. E., *Can. J. Phys.*, **32**, 65 (1954).
i, Stanford, G. S., Duckworth, H. E., Hogg, B. G., and Geiger, J. S., *Phys. Rev.*, **85**, 1039 (1952).

The masses of the twenty-two monoisotopic elements, with appropriate footnotes indicating their source, are shown in the accompanying table, and their values on the chemical scale are compared with the official chemical atomic weights. The value of the conversion factor from the chemical to the physical scale has been taken to be $1{\cdot}0002783 \pm 5$, as recently determined[3] by Nier for atmospheric oxygen. There is seen to be exact agreement in the case of eleven elements; in three cases the approved value is too small; while for the remaining eight elements it is too large, sometimes by a substantial amount.

Some of these discrepancies have been recognized by the Committee on Atomic Weights. In its 1951 Report, the Committee remarked[4] that revisions appeared necessary in the cases of sodium, manganese, terbium, thulium and gold, and even suggested the direction and probable magnitude of the changes likely to be made at the time of the next formal report. These suggested revisions would remove the discrepancies for sodium, manganese, terbium and gold; but the proposed value of 169·0

for thulium would be slightly too high. It is desirable that the revisions indicated by the table should also be made for the elements arsenic, yttrium, praseodymium, tantalum, bismuth and thorium.

One is tempted to assess the adequacy of the chemical techniques for a given element by comparing its chemically determined atomic weight with that computed from physical data. For this purpose the table presents a somewhat over-optimistic picture, in that the official atomic weights of aluminium, phosphorus, scandium and iodine have already been revised by the Committee to coincide with the physical values. There is, therefore, exact agreement between the chemically and physically determined values for substantially less than half the elements in this group. It is not proper to generalize on the basis of this comparison since the monoisotopic elements are not, in a chemical sense, representative. With the exception of beryllium and thulium, they are all elements of odd atomic number and, hence, represent only some of the chemical families.

This work has been supported by the Office of Scientific Research, Air Research and Development Command, U.S. Air Force, and the National Research Council of Canada. [June 25.

[1] Scott, A. F., and Bettman, M., *Chem. Rev.*, **50**, 363 (1952).
[2] Collins, T. L., Johnson, jun., W. H., and Nier, A. O., *Phys. Rev.*, **94**, 398 (1954).
[3] Nier, A. O., *Phys. Rev.*, **77**, 789 (1950).
[4] Wichers, E., *J. Amer. Chem. Soc.*, **74**, 2447 (1952).

WHY USE INBRED LINES?

By Dr. J. D. BIGGERS and P. J. CLARINGBOLD

Department of Veterinary Physiology, University of Sydney

THE use of inbred lines of both plants and animals has often been recommended in biological investigation. Recently, in order to find the basis of the recommendation, we have examined the literature. The purpose of this communication is to bring to general notice the present state of knowledge on the use of inbred lines. In communications which have appeared since the present article was first submitted for publication, Grüneberg[1] and McLaren and Michie[2] have dealt with the same problem. The genetic aspects of this problem have been discussed by Grüneberg and will not be considered further.

In the second decade of this century, inbred lines of guinea pigs and rats were developed; in the case of the rat, the descendants became the well-known Wistar strain. The inbred rats were characterized by a uniform body-weight and appearance, in contrast to randomly bred animals[3].

Soon after this period, the standardization of hormones and vitamins was developed. A unit of these substances was often arbitrarily defined in terms of a standard animal; for example, a unit of the parathyroid hormone was defined "as 1/500th of the amount required to produce in a dog of 20 kg. weight an increase of 5 mg./100 c.c. in serum calcium in 15 hours"[4]; the rat unit of œstrogen was defined as "the quantity of material necessary to induce œstrus as judged by the smear method in an ovariectomized, sexually mature rat weighing 140 ± 20 gm."[5]. These early definitions indicate that great value was placed on strains possessing uniform bodily characteristics, and it was for this reason that the Wistar rats were rapidly distributed[6].

Investigators soon recognized that the definition of the original 'animal units' of hormones and vitamins completely overlooks the effect of variation between animals. The establishment of international standards, in the mid-thirties, overcame this objection and at the same time led to the adoption of biometric techniques[7]. In these methods an estimate is made of the experimental error, and this is used for giving fiducial limits to relative potency estimates. In the wider field of biological experimentation, the estimate of experimental error is used to judge the significance of treatment effects[8]. Cochran and Cox[9] list three main ways of decreasing experimental error: (1) by increasing the size of the experiment, (2) by refining the experimental technique, (3) by handling the experimental material so that the effects of variability are reduced. We may include in the third of these methods the selection of homogeneous biological material. In many assays[10], for example, growth assays[11], the variability within litters is considerably less than the variability between litters. Since litters are genetically more uniform than the population as a whole and their use gives greater accuracy in bioassay, it was concluded that the use of genetically homogeneous inbred animals would also increase accuracy.

Thus over a period of about thirty-five years a traditional desire for inbred lines has developed, and these have been recommended in many modern text-books and many papers. We have not found one published investigation of the response to a treatment in which the advantage of inbred lines over randomly bred animals has been experimentally substantiated. In his recent book on the statistics of bioassay, Finney[10] gives two references on the subject.

The first reference is, through Gaddum[12], to the work of Winton[13] on the assay of red squills. In the original paper, Winton concluded that one inbred Wistar rat was equivalent to ten rats of mixed origin (black, black-and-white, and wild). No efficient statistical method was then available for the analysis of these results. In 1933 Gaddum[12] re-examined Winton's data using the newly devised normal equivalent deviate transformation, and he concluded that one Wistar rat was equivalent to six mixed rats. The statistical analysis applied by Gaddum is also inefficient, since iteration was not carried out to the maximum likelihood estimates and empirical weights were used. This procedure may seriously bias the estimates when the number of animals in an experiment is small and many 0 and 100 per cent responses occur, as in Winton's data. Consequently, we have re-examined his figures using the standard modern probit technique[14].

Winton's data have been grouped into intervals (range 0·2 gm./kgm.) for the purpose of analysis. Death (D) has been scored as a positive response, and survival (which includes unaffected (N) and convulsed (C)) has been scored as a negative response. A log dose/probit response regression line has been fitted by the method of maximum likelihood to each set of data, iteration being continued until successive values of the regression coefficient (slope) differ by less than one-tenth of the standard error[15]. An analysis of the slope differences has been made by a partitioning of χ^2 (Table 1). Since slope is the

Table 1. PARTITIONING OF χ^2 FOR THE DATA OF WINTON (ref. 13)

Source of variation	D.f.	χ^2	P
Between strains	(2)		
Inbred ♀ v. Inbred ♂	1	0·01	$0·95 > P > 0·90$
Inbreds v. Mixed	1	1·24	$0·3 > P > 0·2$
Heterogeneity	26	23·51	$0·7 > P > 0·5$

reciprocal of the square root of the variance of the individual effective doses of the population, this analysis is an examination of variability. Although the estimates of slope suggest a difference between the inbred and mixed animals, the analysis indicates that the differences are those of random sampling. This efficient analysis provides no evidence of a significant difference between the mixed and inbred animals and therefore the conclusions of Winton and Gaddum are incorrect. Furthermore, it must be emphasized that the mixed stock of rats used by Winton is a heterogeneous collection and not a randomly bred strain, and had a significant difference been found its interpretation would still be difficult.

The second reference given by Finney is to the work of Morrell and Allmark[16] on the toxicology of neoarsphenamine in rats. While it is doubtful if the animals used in this investigation fulfil the definition of inbred, they were not found to be significantly better than randomly bred animals.

Emmens[17] studied the action of œstrone in Strong's *CBA* strain of mice and found, to his surprise, that they were significantly more variable in response than the randomly bred colonies normally used. Recently this finding has been confirmed in *CBA* and *C57* mice, using œstrone and œstradiol-3 : 17β [18]. In both these investigations the mice were inbred to at least thirty generations and may thus be considered homozygous. Since inbred lines are so often recommended, it is very surprising that little work can be found on the comparison of the variability of inbred and randomly bred animals. The experimental work reviewed above offers no evidence that inbred lines may be advantageous and even suggests they may be disadvantageous.

A considerable and well-established disadvantage of inbred lines is the decline in vigour often associated with inbreeding[19]. This is manifested in a decline in fertility, fecundity and health. When a large colony is required, many breeding animals need to be maintained in order to produce the colony in a reasonable time.

It has been known for many years that F_1 hybrids between inbred lines are characterized by high vigour. This phenomenon is known as heterosis or hybrid vigour, and has been discussed extensively in recent times[20,21]. In addition, the hybridization of inbred lines leads to two other phenomena : (1) the mean response of the F_1 generation often lies outside the interval between the mean responses of the parental stocks ; (2) the F_1 generation is less variable than the parent inbred populations. The first phenomenon has often been described and studied because of its economic importance. The second phenomenon, however, has been studied very little and only an occasional reference may be found.

McLaren and Michie[3] have recently demonstrated that the variability of inbreds is 3·5 times greater than that of F_1 hybrids, using the duration of narcosis to sodium pentabarbital as the test criterion. Claringbold and Biggers[18] have studied the vaginal response to œstrogens of reciprocal F_1 hybrids of *C57* and *CBA* mice and found the hybrids to have 25 per cent of the variability of the inbreds, and they were always less variable than the randomly bred albino stock. Thus in studies of œstrogens the use of these F_1 hybrids has tremendous advantages because of the large reduction in biological variation.

Strong[22] states that the use of F_1 crosses deserves consideration. However, his reasons are based on the fact that F_1 hybrids are superior to inbreds in health and longevity, and that "animals of any particular hybrid type show as great uniformity as the inbreds do". This latter statement is true so far as genetic variability is concerned, but ignores the possibility of interaction between genotype and environment. Fisher[23], too, suggests the out-crossing of two inbred lines to produce a large number of genetically uniform mice in a short time. The low vigour of inbred animals results in a low weaning-rate, but following hybridization the weaning-rate is high. In the case of mice the litter size of hybrids may be two to three times greater than the litter size of inbreds. Thus the F_1 hybrids are much the easier to breed in large numbers, and only a small stock of inbred animals need be maintained for their production.

In view of the above considerations, the automatic use of inbred lines may well be an inefficient procedure in biological experimentation. Investigators should examine their material to see whether inbreds, F_1 hybrids or randomly bred animals are the most suitable for their work. It is probable that the best use of inbred lines is to produce F_1 hybrids. The manifestation of heterosis, however, will depend on the material studied and no general rule can be laid down. In the concluding paragraphs of his book, "The Theory of Inbreeding", Fisher[23] discusses the necessity of having many inbred lines so that suitable crosses can be made for special environments and purposes. Although this was written with particular reference to livestock and plant improvement, it is possible that these ideas could be exploited in experimental procedures.

[1] Grüneberg, H., *Nature*, **173**, 674 (1954).
[2] McLaren, A., and Michie, D., *Nature*, **173**, 686 (1954).
[3] King, H. D., *J. Exp. Zool.*, **29**, 71 (1919).
[4] Evans, C. L., "Starling's Principles of Human Physiology" (Churchill, London, 1941).
[5] Doisy, E. A., Ralls, J. C., Allen, E., and Johnston, C. G., *J. Biol. Chem.*, **61**, 711 (1924).
[6] Bacharach, A. L., *Pharm. J.*, **62**, 629 (1926).
[7] Coward, K. H. "The Biological Standardization of the Vitamins" (2nd ed., Baillière, Tindall and Cox, London, 1949).
[8] Fisher R. A., "Design of Experiments" (3rd ed., Oliver and Boyd, Edinburgh, 1949).
[9] Cochran W. G., and Cox, G. K., "Experimental Design" (Wiley, New York, 1950).
[10] Finney, D. J., "Statistical Method in Biological Assay" (Griffin, London, 1952).
[11] Bliss, C. I., and György, P., in "Vitamin Methods", **2**. Edit. by P. György (Academic Press, New York, 1951).
[12] Gaddum, J. H., Spec. Rep. Ser., Med. Res. Coun., No. 183 (1933).
[13] Winton, F. R., *J. Pharmacol.*, **31**, 123 (1927).
[14] Finney, D. J., "Probit Analysis" (2nd ed., Camb. Univ. Press, 1952).
[15] Fisher, R. A., and Yates, F., "Statistical Tables" (3rd ed., Oliver and Boyd, Edinburgh, 1953)
[16] Morrell, C. A., and Allmark, M. G., *J. Amer. Pharm. Assoc.* **30**, 33 (1941).
[17] Emmens, C. W., *J. Endocrinol.*, **1**, 373 (1939).
[18] Claringbold, P. J., and Biggers, J. D., *J. Endocrinol.* (in the press).
[19] Srb, A. N., and Owen, R. D., "General Genetics" (Freeman, San Francisco, 1952).
[20] Rendel, J. M., *Amer. Nat.*, **87**, 129 (1953).
[21] Gowen, J. W., "Heterosis" (Iowa State College Press, 1952).
[22] Strong, L. C., in "The Care and Breeding of Laboratory Animals" chapter 3, edit. by E. J. Farris (Wiley, New York, 1950)
[23] Fisher, R. A., "The Theory of Inbreeding" (Oliver and Boyd, Edinburgh, 1949).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Psalliotin, the Antibiotic of *Psalliota xanthoderma*

The antibiotic activity of the edible mushroom *Psalliota xanthoderma* was first described in some detail by Atkinson[1] in Australia. Wilkins[2] in England also recorded this mushroom as being antibiotic. Atkinson gave a number of characteristics of the antibiotic substance and also a list of sensitive and insensitive bacterial species, but refrained from naming the substance as a new antibiotic. Its peculiar and haphazard lability defeated attempts to concentrate and purify it, and the work was temporarily abandoned as the mushroom supply ran out.

This year a good crop of *Psalliota xanthoderma* appeared in and around Adelaide and work on purification of the antibiotic was recommenced using paper chromatography of aqueous extracts of mushroom stipes. Erratic results were obtained, some papers showing a good antibiotic zone near the solvent front, others showing no zone. The amount of activity on the paper was shown to depend upon the extent of exposure to daylight during the preparation of the spot of mushroom extract (100 μl.) and during the running and subsequent handling of the chromatogram. Spots prepared in dim light, run in the dark and afterwards handled in dim light, invariably produced antibiotic zones near the solvent front.

The sensitivity of the antibiotic in crude extracts to different types of light was investigated by exposing dried spots of extract (100 μl.) for various times to the diffuse daylight (not direct sunlight) of the working bench under the window. At the same time, and in the same position, similar spots were exposed under various Wratten filters, and a control spot was kept in a light-proof box.

This box control spot tested after four hours and twenty-four hours on the bench at room temperature showed excellent activity comparable to that of a similar spot kept in the dark in the refrigerator. Thus no deterioration occurred in twenty-four hours at room temperature in the dark. Rapid deterioration occurred, however, in diffuse daylight, as little or no activity was detected in the spots exposed directly to daylight for one to four hours. Good activity similar to the box control was found in spots exposed up to four hours under Wratten filters *A*, *B*, *C*, *E*, *F*, *G*, *H* and *Kl*, which were thus protective. The *D* filter (dark violet) was not protective, however. Spots exposed under it for one to four hours showed reduced or barely detectable activity.

Exposure to short-wave ultra-violet also inactivated the antibiotic extract. With the lamp used at present, emitting mainly in the 250 mμ region, complete inactivation of dried spots occurred at 18 cm. distance in one hour, and considerable reduction of activity in twenty minutes. Long-wave ultra-violet was probably responsible to a large extent for the inactivation produced by daylight, as spots placed under glass, which blocked short-wave ultra-violet, showed little or no activity after exposure to daylight in the usual place on the bench for one to four hours.

As the yellow Wratten filters protected the antibiotic activity and gave good light transmission, a suitable source of yellow light was sought for use during experimental work on the antibiotic extracts. Of various sources tried, a Philips yellow dark-room globe was found most satisfactory. Spots exposed up to six hours under this light in a black box showed no reduction in activity. Thus work on this antibiotic mushroom may be safely carried out in this yellow light in an otherwise darkened room.

The conclusion arising from this work is that the main destructive agent for the *Psalliota* antibiotic in crude extracts is bright light. Success can only be achieved by continually protecting it from bright light. Earlier work must therefore be repeated under suitable lighting. Many earlier results have already been checked and purification procedures are being carried out either in the dark or in the yellow light.

Because of its light sensitivity in crude extracts, the antibiotic of *Psalliota xanthoderma* appears to be new and unique. Therefore it may justifiably and conveniently be given the new name psalliotin.

A detailed account of this work will be published elsewhere.

Nancy Atkinson

Department of Bacteriology,
University of Adelaide,
South Australia.
Aug. 26.

[1] Atkinson, N., *Aust. J. Exp. Biol.*, **24**, 169 (1946); *Med. J. Aust.*, **1**, 605 (1949).

[2] Wilkins, W. H., *Ann. App. Biol.*, **33**, 188 (1946).

Antibiotic Production by Actinomycetes in Soil demonstrated by Morphological Changes induced in *Helminthosporium sativum*

It has often been suggested that the production of antibiotics in soil is at least partly responsible for the antagonistic relationships between actinomycetes and plant pathogenic fungi; but little direct evidence has been obtained to offset the fact that these substances have rarely been extracted from soil.

A number of soil actinomycetes were selected for their antibiotic activity towards *Helminthosporium sativum*. These actinomycetes were shown to reduce root-rot of wheat when inoculated simultaneously with the fungus into sterile soil. Reduction in disease incidence was correlated with the degree of antagonism exhibited by the actinomycetes *in vitro*, suggesting that antibiotics were responsible for the disease control. In these experiments we were unable to extract the active antibiotic from the soil, but the possibility remained that antibiotics were present in sufficient concentrations to cause localized effects in soil.

A number of workers have described morphological changes in fungi caused by antibiotics, and it appears that these substances affect the morphological development of a given fungus in a characteristic and reproducible manner[1–3].

In vitro experiments were carried out to determine the effects of the antibiotics produced by the selected actinomycetes on the spores and hyphæ of *H. sativum*. Inhibition of development and morphological changes of the fungus varied with the actinomycete, but the effects noted were quite characteristic. *H. sativum* spores either failed to germinate or were inhibited at a point just subsequent to germination. Antibiotic effects on the hyphæ of *H. sativum* were determined by germinating the fungal spores for twenty-four hours before placing them in the presence of the

actinomycetes. Hyphal changes ranged from the stoppage of further mycelial development to such characteristic morphological effects as stunting, distortion or the formation of hyphal protuberances.

To demonstrate the effects of the actinomycetes on *H. sativum* in soil a buried-slide technique was employed[1]. Microscope slides dipped into a plain agar suspension of *H. sativum* spores were placed in pots of sterilized soil inoculated with one of the actinomycetes. In a similar manner the effect on the fungal hyphæ was determined by incubating the agar slides prior to placing in the soil. It was possible to determine the effects of the actinomycetes on the fungus by periodic removal and microscopical examination of the slides. In all cases the characteristic morphological effects caused by the actinomycete antibiotics *in vitro* were noted in the soil. Extraction procedures again failed to demonstrate the presence of antibiotics in the soil.

Further proof of the activity of antibiotics in soil was obtained using the antibiotic actinomycin and *Actinomyces antibioticus*, the organism responsible for its production. In Petri-dish culture both crystalline actinomycin and *A. antibioticus* produce a characteristic swelling, distortion and stunting of the fungal hyphæ. When introduced into sterile soil identical morphological changes are evidenced by *H. sativum* in the presence of either the pure antibiotic or *A. antibioticus*. Extraction of the soil containing the actinomycete yielded no antibiotic, strongly suggesting a localized antagonism due to a relatively high concentration of antibiotic in the immediate vicinity of the actinomycetes.

I. L. Stevenson

Soil Microbiology Department,
Rothamsted Experimental Station,
Harpenden, Herts;
and
Division of Bacteriology,
Science Service,
Department of Agriculture,
Ottawa, Canada.
Aug. 9.

[1] Brian, P. W., Curtis, P. J., and Hemming, H. G., *Trans. Brit. Mycol. Soc.*, **29**, 173 (1946).
[2] Porter, C. L., *Amer. J. Bot.*, **11**, 168 (1924).
[3] Elliot, J. A., *Amer. J. Bot.*, **4**, 439 (1917).
[4] Chinn, S. H. F., *Can. J. Bot.*, **31**, 718 (1953).

Isolation and Characterization of Biosynthetic Arylsulphates

Although most phenols are known to be partially excreted as the corresponding sulphate esters, few arylsulphuric acids have actually been isolated from urine, mainly because of the great solubility of the compounds and their sodium and potassium salts. The *p*-toluidine[1] and *p*-bromoaniline[2] salts are less soluble and can be used to isolate arylsulphates after some preliminary purification of the urine[3], but are not very satisfactory when the arylsulphates are present in small amounts.

The findings of Egami[4] that trypaflavin (10-methyl 2 : 8-diaminoacridinium chloride) gave insoluble salts with many different sulphate esters suggested to us that this type of compound might be used to separate arylsulphates from urine. A number of aminoacridines, aminoquinolines and aminopyridines were found to give insoluble salts with arylsulphates, and of the compounds tested 5-aminoacridine was particularly suitable because of its availability and the great insolubility of its readily crystallized arylsulphate salts. The solubilities of these salts in water is of the order of 0·03 gm./100 ml. at 4° C., and they were therefore much less soluble than the *p*-toluidine and *p*-bromoaniline salts mentioned earlier. Unfortunately, the salts do not melt sharply.

A large number of urinary constituents, including some detoxication products, do not give insoluble salts with 5-aminoacridine with the exception of the glucuronides of stilbœstrol and dienœstrol, both of which are known to form relatively insoluble sodium salts[5]. Other compounds which readily gave insoluble 5-aminoacridine salts included dehydro-*iso*androsterone sulphate, di-*iso*propylidene glucose 3-sulphate and the polysaccharide sulphates, carraghenin, laminarin, fucoidin and chondroitin sulphate.

Use has been made of 5-aminoacridine to isolate the monosulphate of 4-chlorocatechol from the urine of rabbits receiving this compound. Methylation of the free hydroxyl group of the 5-aminoacridine salt and identification of the methylated phenol liberated by subsequent acid hydrolysis established the structure of 4-chlorocatechol monosulphate as 2-hydroxy 4-chlorophenyl sulphate. This confirms the suggestion of Dodgson and Williams[6] that sulphate conjugation of 4-chlorocatechol occurred on the hydroxyl group para to the substituent chlorine atom.

An arylsulphate isolated as the 5-aminoacridine salt from the urine of rabbits receiving chlorobenzene, and the monosulphate resulting from the treatment of 4-chlorocatechol with half the theoretical amount of chlorosulphonic acid, were shown in the same way to be identical with the arylsulphate obtained after feeding 4-chlorocatechol.

A detailed account of this work will be published elsewhere.

K. S. Dodgson
F. A. Rose*
B. Spencer

Physiology Institute,
Newport Road,
Cardiff. June 16.

* Medical Research Council Student.

[1] Barton, A. D., and Young, L., *J. Amer. Chem. Soc.*, **65**, 294 (1943).
[2] Laughland, D. H., and Young, L., *J. Amer. Chem. Soc.*, **66**, 657 (1944).
[3] Berenbom, M., and Young, L., *Biochem. J.*, **49**, 165 (1951).
[4] Egami, F., *J. Chem. Soc. Japan*, **60**, 853 (1939).
[5] Dodgson, K. S., Garton, A. G., Stubbs, A. L., and Williams, R. T., *Biochem. J.*, **42**, 357 (1948).
[6] Dodgson, K. S., and Williams, R. T., *Biochem. J.*, **45**, 381 (1949).

Effect of Temperature on the Inactivation of Phage labelled with Phosphorus-32

In the course of investigations on phage *BM* labelled with phosphorus-32, we have had occasion to study its inactivation at a temperature of 2–4° C. and at that of 'dry ice' (− 79° C.). In this way an effect of temperature on the rate of inactivation has been observed, a result which may be of interest in wider investigations recently made by various authors[1] on the combined effects of temperature and ionizing agents on viruses and protein molecules.

The investigation has been carried out with the phage *BM* active on *Bacillus megatherium* which has been studied for some years in our laboratory[2]. The labelled phage was prepared by infecting cells of *B. megatherium* which had been grown in semi-synthetic medium containing about 3 mc. of phosphorus-32

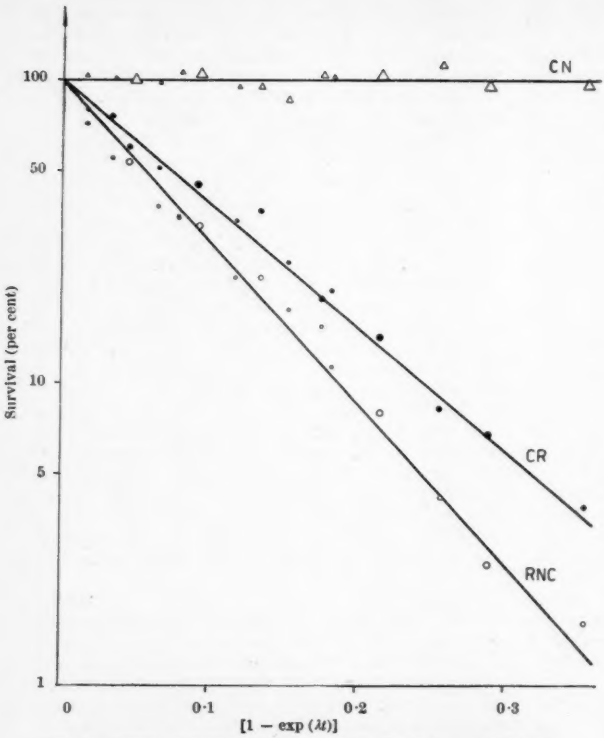


Fig. 1. RNC = labelled phage not frozen (2° C.), equation being $y = \exp\{-12{\cdot}3\,[1 - \exp(-\lambda t)]\}$; CR = labelled phage frozen (− 79° C.), equation being $y = \exp\{-9{\cdot}3\,[1 - \exp(-\lambda t)]\}$; CN = unlabelled phage frozen (− 79° C.). The three sizes of circles and triangles represent respectively the weighted mean values of three experiments, weighted mean values of two experiments and the values of one experiment respectively

per ml. and with a phosphorus-32/phosphorus-31 ratio which varied from 1×10^{-3} to 4×10^{-4} in the various experiments. The concentration of the phage obtained in this medium was 10^{10} particles per ml. of labelled phage, with an increase by a factor of 10^5 with respect to the unlabelled phage introduced for the infection.

Immediately after the lysis, dilution to about 10^{-6} is carried out with broth to exclude any action of the unassimilated phosphorus-32.

The phage particles obtained under these conditions undergo a rapid inactivation caused by the decay of the phosphorus contained chiefly in their deoxyribonucleic acid. According to Hershey *et al.*[3], this inactivation can be attributed largely to the transformation of phosphorus-32 to sulphur-32, which takes place in the genetic structures of the phage, and only to a negligible extent to the passage of the β-particles through the vital structures.

Samples of radioactive phage suspended in broth were frozen to − 79° C. by techniques which will be described in a later publication, and kept at this temperature for days or weeks. Samples of non-radioactive phage were also frozen by the same procedure, and from Fig. 1 it is evident that the technique adopted excludes any mortality due to freezing.

Samples were taken periodically to check the value of the inactivation and for control. At the same time suspensions of radioactive phage were kept at a temperature of 2–4° C. and tested periodically for inactivation.

The duration of our experiments, the temperature and the medium in which the particles were suspended exclude any mortality independent of the radioactivity.

As can be seen clearly from Fig. 1, our results (which refer to three experiments giving very consistent results) suggest a highly significant difference in the rate of inactivation, a difference which can be calculated as about 25 per cent less for the frozen radioactive phage.

This difference can be attributed to various possible causes including: (1) a diminished rate of diffusion of the toxic ions produced by β-rays inside the phage particles when kept at a low temperature and in the solid state; in fact in this case toxic ions produced inside non-sensitive structures tend to remain localized and have no lethal effect in structures farther away[4]; (2) a lower production at low temperatures by electrons of hydrogen peroxide, with a consequent diminution of the lethal action[5]; (3) a contraction of the sensitive structures[4]; that is, a decrease with temperature of the length of certain chemical bonds with a consequent increase in their stability with respect to β-ray action and a decrease of the radiosensitive volume.

Since the effect of temperature observed by us cannot in any event be attributed to radioactive decay, it suggests that the transformation of phosphorus-32 to sulphur-32 contributes only to a limited extent, which cannot be evaluated at present, to the causes of death. The experiments now in progress on the inactivation of labelled *BM* phage after its penetration into unlabelled cells may give more suitable results for this evaluation.

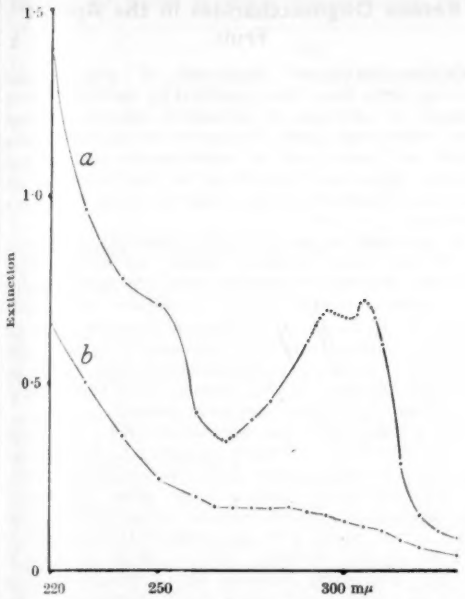
C. Castagnoli
Istituto di Fisica dell 'Università, Roma.

F. Graziosi
Istituto di Microbiologia dell 'Università, Roma. June 8.

[1] Adams, W. R., and Pollard, E. C., *Arch. Biochem. and Biophys.*, **38**, 311 (1952). Wood, T. H., *Nature*, **173**, 641 (1954).
[2] Graziosi, F., and Russo, G., *Rend. Ist. Sup. San.*, **14**, 839 (1951). Calef, E., Atti VIII Cong. Naz. Microb., Milano 1952, p. 250. Castagnoli, C., and Graziosi, F., *Rend. Ist. Sup. San.*, **15**, 148 (1952).
[3] Hershey, A. D., Kamen, M. D., Kennedy, J. W., and Gest, H., *J. Gen. Physiol.*, **34**, 305 (1951).
[4] Pollard, E. C., "Advances in Biological and Medical Physics", 181 (1953).
[5] Bonét-Maury, *Brit. J. Radiol.*, **24**, 422 (1951).

A Constituent of Male Sperm Antagglutin related to Vitamin E

Through a number of unknown factors in the male and the female genital apparatus, the head surface of mammalian spermatozoa is influenced in such a way as to bring about agglutination. This state of the cell surface is probably in some way important for the fusion at fertilization. On the other hand, agglutinated spermatozoa are unable to fertilize[1], and the tendency to agglutinate is normally opposed by a special proteid produced in the prostatic gland. This was called 'sperm antagglutin'[2]. From this



proteid a group may be split off with the same biological potencies as the native substance. Sperm antagglutin, as well as its active group, occurs in reduced and oxidized forms, which may be reversibly transformed into each other. In both cases only the reduced form is biologically active. The active group was shown, *inter alia*, to contain sugar[2] and probably also sulphuric acid residues[3].

Further, we have now isolated from male sperm antagglutin a substance which is very slightly soluble in water and easily dissolved in ethanol and ethyl ether. The general type of the extinction curve of this substance in ethanol (Fig. 1*a*) very nearly conforms to that of α-tocopherol in hexane (cf. ref. 4). Oxidation with nitric acid according to Ungnade and Smith[5] yields a yellow colour, however, with the absorption maximum at 405 mμ, typical of the red oxidation product of α-tocopherol[6]. When dissolved in *n*-hexane, the conventional solvent for spectroscopical examinations on this group of substances, the material showed an extinction curve of quite another type (Fig. 1*b*). Samples brought back into ethanol after being examined in *n*-hexane give extinction curves the form of which was now exactly the same as in hexane. This indicates the occurrence of some interaction between the substance in question and some constituent of the 'hexane'. This change of the extinction curve was brought about by all kinds of commercial *n*-hexane (also that "for spectroscopical use" from the British Drug Houses, Ltd.). Only when freshly purified hexane was used was the change more or less reversible.

Under certain conditions a product with absorption maxima at 292 and 325 mμ in ethanol has been obtained, showing the same type of curve in *n*-hexane. In this solvent the maxima are at 289 and 315 mμ. Postulating a corresponding displacement of the maxima of curve *a* in Fig. 1 in the transfer from ethanol to *n*-hexane, these two maxima would be expected to occur at 292 and 298 mμ in the later solvent. These figures are identical with those given for α-tocopherol in *n*-hexane (cf. ref. 4).

This tocopherol derivative probably is the reversibly oxidized and reduced component of the male sperm antagglutin and its active group. The abolition of the absorption maxima in hexane gives a clue as to the mechanism by which those of tocopherol are being suppressed in the native antagglutin (cf. Fig. 1 of ref. 2).

We are indebted to the Swedish Agricultural, Medical and Natural Science Research Councils for financial support.

P. E. Lindahl
J. E. Kihlström

Institute of Zoophysiology,
University of Uppsala.
June 9.

[1] Andersson, J., "The Semen of Animals and its Use for Artificial Insemination" (Imp. Bur. Animal Breed. and Genetics, Edinburgh, 1945).
[2] Lindahl, P. E., and Kihlström, J. E., Rep. 2nd Intern. Congr. Physiol. Pathol. Animal Reprod., Copenhagen, 70 (1952); *Fertil. and Steril.*, **5**, 241 (1954).
[3] Kihlström, J. E., *Arkiv f. Kemi* (in the press).
[4] Evans, H. M., Emerson, O. H., and Emerson, G. A., *J. Biol. Chem.*, **113**, 319 (1954). Emerson, O. H., Emerson, G. A., Mohammad, A., and Evans, H. M., *J. Biol. Chem.*, **122**, 99 (1937–38). Webb, T. J., Smith, L. J., Bastado, W. A., Ungnade, H. E., Prichard, W. W., Hoehn, H. H., Wazonek, S., Opie, J. W., and Austin, F. L., *J. Org. Chem.*, **4**, 389 (1939).
[5] Ungnade, H. E., and Smith, L. I., *J. Org. Chem.*, **4**, 397 (1939).
[6] Ridgway, R. R., Drummond, J. C., and Wright, M. D., *Biochem. J.*, **34**, 1569 (1940).

A Comparison of some Natural and Synthetic Melanins

The identity of natural and synthetically prepared melanins is still not proved[1–3]. My investigations suggest that some of the members of these two classes of melanins possess a similar structure.

Preparation *A* was a natural melanin prepared from the choroid of the ox eye. After careful removal, the choroids were refluxed with 2 *M* hydrochloric acid for 50 hr. Most of the tissue dissolved to give a yellow solution, whereas the pigment remained as an acid-insoluble, red-brown mass. This was dissolved in 5 *M* sodium hydroxide. Some of the acid-insoluble residue did not dissolve in the alkali and was discarded. The alkaline solution was acidified with hydrochloric acid, whereupon the pigment was precipitated. Repeated solution in *M* sodium hydroxide and reprecipitation with acid, followed by washing with distilled water, was performed until a constant nitrogen percentage was obtained from the dry precipitate. Three such precipitations were usually sufficient to obtain such constancy. The final precipitate was redissolved in 0·01 *M* sodium hydroxide.

Preparation *B* was a synthetic melanin prepared by the autoxidation of β-3 : 4 dihydroxyphenylalanine ('dopa') according to Arnow[4]. A thrice-reprecipitated preparation was used. This was considered to be the purest melanin and was used as a standard. The pigment was dissolved in 0·01 *M* sodium hydroxide.

Preparation *C* was a synthetic melanin prepared according to Raper[5] from tyrosine, using potato tyrosinase buffered at *p*H 6·8.

Preparation *D* was a synthetic melanin prepared from tyrosine and potato tyrosinase buffered at *p*H 7·4. In both *C* and *D* a thrice-reprecipitated preparation was obtained and was dissolved finally in 0·01 *M* sodium hydroxide.

Fig. 1 shows the ultra-violet absorption spectra (obtained using a Beckman spectrophotometer) of the sodium hydroxide solutions of the four melanins. A 'bump' in the region of 270 mμ is just noticeable in curves for *A* and *B*, whereas those for *C* and *D* show

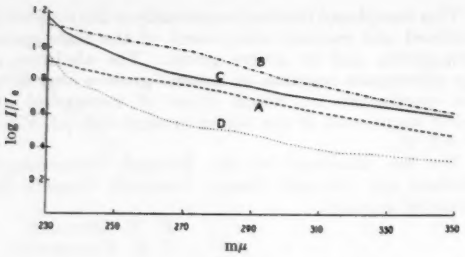


Fig. 1

a bump at 285 mμ. The *p*H has little effect on the shape of the curve.

Such a bump is also evident in the absorption curves of the melanin from dihydroxyphenylalanine of Clemo *et al.*[3], and in those for melanin from tyrosine of Florence *et al.*[6], but was not commented upon by these workers. Bowness *et al.*[7] obtain similar bumps (at 280 mμ) using an enzymic oxidation procedure, but ascribe them to the presence of dihydroxyphenylalanine. Mason[8] showed, however, that solutions of dihydroxyphenylalanine do not possess such an absorption maxima after a short exposure to air, an observation confirmed during the present work. The similar bump in the curve for the natural melanins is not depicted on the curves for preparations made by Florence *et al.*[6], presumably due to masking by contaminants in a less pure preparation.

The curves obtained here suggest that melanin from dihydroxyphenylalanine and the natural melanin have a similar chemical structure which, however, appears to differ from that of melanin prepared enzymatically from tyrosine, whether the latter is prepared in an acidic or an alkaline medium. It appears likely therefore that the enzymic oxidation of dihydroxyphenylalanine and the aerobic autoxidation of this substance involve different reaction sequences, and that a reaction sequence similar to the aerobic autoxidation is followed by dihydroxyphenylalanine during its oxidation in the environment of the ox eye choroid.

Further work in progress indicates that a melanin, prepared in a manner similar to the above, from human black hair, has an almost identical absorption spectra to that of the melanin isolated from the ox choroid. It exhibits a similar bump at 270 mμ. Thus melanin from dihydroxyphenylalanine, from ox choroid and from human black hair, appear to be formed by similar reaction sequences.

I wish to thank Prof. Joseph Gillman for suggesting this problem to me, and to thank him and Drs. P. R. Levy and G. N. Festenstein for their advice and criticism.

W. D. Stein

Department of Physiology and
Joint Nutrition Research Unit of the
Council for Scientific and Industrial Research
and the University of the Witwatersrand,
Medical School, Johannesburg.

May 26.

[1] Ginsburg, B., *Genetics*, **29**, 176 (1944).
[2] Mason, H. S., "Biology of Melanomas", Spec. Pub. N.Y. Acad. Sci., 399 (1948).
[3] Clemo, G. R., and Duxbury, F. K., *J. Chem. Soc.*, 1795 (1950).
[4] Arnow, L. E., *Science*, **87**, 308 (1938).
[5] Raper, H. S., and Wormall, A., *Biochem. J.*, **17**, 454 (1923).
[6] Florence, G., Enselme, J., and Pozzi, M., *Bull. Soc. Chim. Biol.*, **17** 268 (1935).
[7] Bowness, J. M., and Morton, R. A., *Biochem. J.*, **53**, 620 (1953).
[8] Mason, H. S., *J. Biol. Chem.*, **172**, 83 (1948).

Ketose Oligosaccharides in the Apricot Fruit

Oligosaccharides composed of glucose and fructose units have been detected by various workers recently in extracts of Jerusalem artichoke, wheat flour, barley and agave. A number of oligosaccharides which are hydrolysed by invertase to glucose and fructose have now been found in ripe apricots. In one case a hexitol was also detected in the hydrolysis products.

A de-ionized aqueous solution was prepared from an 80 per cent alcoholic extract of apricot fruit (variety, Trevatt). Aliquots were chromatographed on a cellulose column using *iso*-propanol–*n*-butanol–water (7 : 1 : 2), or on a charcoal column using increasing concentrations of aqueous ethanol; the fractions containing oligosaccharides were re-run on charcoal columns. It then became clear that at least six ketose oligosaccharides were present.

The predominant oligosaccharide (*K*3; see Table 1) was present in sufficient quantity to be detected on paper chromatograms of the original fruit extract. It appeared to be homogeneous after the second fractionation on charcoal but did not crystallize. The dried syrup (yield, 0·07 per cent of the fresh fruit) had an optical rotation $[\alpha]_D^{20} = 24{\cdot}3°$ (*c*. 4·94 in water). The sugar behaved like a trisaccharide on charcoal columns and paper chromatograms. It was hydrolysed by invertase to glucose and fructose, which were separated on paper and estimated with anthrone[1]; the ratio glucose : fructose was 1 : 2. Hydrolysis with *N* sulphuric acid at 100° C. for 4 hr. also gave glucose and fructose; with 20 per cent acetic acid for 4 hr. at 50° C., glucose, fructose and sucrose were formed. The sucrose was eluted from paper chromatograms and its identity deduced from hydrolysis with invertase, R_F values, and colour reactions. *K*3 is probably a trisaccharide of the type O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(?)-β-D-fructofuranoside. The β-fructose link is deduced from the known specificity of yeast invertase. Two similar trisaccharides have been isolated recently from the sugar mixtures obtained by the partial hydrolysis of sucrose with yeast invertase[2] and mould invertase[3]. These are O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(6→2)-β-D-fructofuranoside, (kestose, $[\alpha]_D^{20} = +27{\cdot}3°$)[2], and O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(1→2)-β-D-fructofuranoside ($[\alpha]_D$ between + 30·5 and 32·6°)[3]. The apricot sugar, *K*3, ran farther on paper chromatograms than the major component (presumed to be kestose) in a mixture obtained by the partial hydrolysis of sucrose with yeast invertase; it has not been compared with pure kestose.

The other ketose oligosaccharides were further purified by elution from paper chromatograms developed with ethyl acetate–pyridine–water (8 : 2 : 1). Their R_S values are recorded in Table 1. With the exception of *K*1, they were all non-reducing (3 : 5-dinitrosalicylic acid reagent). The action of invertase on *K*1 gave, as well as glucose and fructose, a substance which, from R_F values and reactions on paper, appeared to be a hexitol (probably sorbitol). *K*1 has now been resolved, by a long run in *n*-butanol–acetic acid–water (4 : 1 : 1), into two components ($R_S = 0{\cdot}72$ and 0·86), both containing fructose, the component with the lower R_S value being a reducing compound.

The oligosaccharides from the apricot (*K*1–*K*6) were compared directly on paper chromatograms with

Table 1. R_S* VALUES OF APRICOT OLIGOSACCHARIDES IN TWO SOLVENTS

Oligosaccharide designation†	R_S	
	n-Butanol–ethanol–water (10 : 1 : 2 v/v)	Ethyl acetate–pyridine–water (8 : 2 : 1 v/v)
*K*1‡	0·74	0·66
*K*2	0·29	0·21
*K*3	0·41	0·34
*K*4	0·49	0·45
*K*5	0·22	0·17
*K*6	0·17	0·12

* Ratio of the distance travelled by the oligosaccharide to the distance travelled by sucrose, the spots being superimposed on the starting line.
† Numbered in order of displacement from a charcoal column.
‡ *K*1 was not resolved by these solvents.

those synthesized from sucrose by yeast invertase (components I–IV[4]) and *K*2, *K*4, *K*5 and *K*6 were shown to differ from the sucrose-invertase products. *K*3 and component II had the same R_S values in several solvents; but this is of small significance as component II is a mixture of two sugars[5] unresolved by paper chromatography.

The occurrence of these fructose-containing oligosaccharides in the apricot suggests the presence of a transfructosidation system. Similar oligosaccharides in the artichoke are apparently formed by enzymic transfer of fructose from inulin to sucrose[6]. In the apricot, sucrose itself is the most likely source of fructosyl radicals.

There are indications that some of these oligosaccharides occur in other fruits. A ketose with an R_S value similar to that of the *K*1 mixture has been detected on paper chromatograms of pear sugars, and traces of a ketose similar to *K*3 have been found in extracts of some pears and peaches.

A. S. F. ASH
T. M. REYNOLDS
Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
Homebush, N.S.W.
June 4.

[1] Fairbairn, N. J., *Chem. and Indust.*, 86 (1953).
[2] Albon, N., Bell, D. J., Blanchard, P. H., Gross, D., and Rundell, J. T., *J. Chem. Soc.*, 24 (1953).
[3] Bacon, J. S. D., and Bell, D. J., *J. Chem. Soc.*, 2528 (1953).
[4] Bacon, J. S. D., and Edelman, J., *Arch. Biochem.*, **28**, 467 (1950). White, L. M., and Secor, G. E., *Arch. Biochem. Biophys.*, **36**, 490 (1952).
[5] Bacon, J. S. D., *Biochem. J.* (in the press), quoted by Gross, D., *Nature*, **173**, 487 (1954).
[6] Edelman, J., and Bacon, J. S. D., *Biochem. J.*, **49**, 446 and 529 (1951).

Occurrence of Fatty Acids with Uneven-numbered Carbon Atoms in Natural Fats

ALTHOUGH the occurrence in natural fats of fatty acids containing odd-numbered carbon atoms, including *n*-heptadecanoic acid and *n*-pentadecanoic acid, has been claimed by various investigators, subsequent work has invariably revealed that such acids are actually equimolecular mixtures of adjacent members of even-numbered fatty acids. The generally accepted view at the present time is expressed by Hilditch[1] as follows: "With the solitary exception of isovaleric acid (found only in the depot fats of the dolphin and porpoise) the molecules of all natural straight-chain fatty acids, saturated or unsaturated, contain an even number of carbon atoms". Work in this laboratory, however, suggests that this view is not correct, and that fatty acids containing odd-numbered carbon atoms do, in fact, occur in some natural fats.

Following the isolation of pure *n*-heptadecanoic acid from hydrogenated mutton tallow as previously described[2], we have now prepared pure *n*-pentadecanoic acid from the same source as well as from hydrogenated shark (*Galeorhinus australis*) liver oil. It has also been shown[3] that hydrogenated ox perinephric fat contains a consecutive series (including odd-numbered carbon acids) of volatile acids from C_2 to C_{10}. This indicates the probable presence of normal uneven-numbered saturated or unsaturated acids in natural fats. Further, without recourse to hydrogenation, pure *n*-pentadecanoic acid has been isolated from butter-fat.

This work is still in progress, and the detailed results will be published elsewhere.

F. B. SHORLAND
Fats Research Laboratory,
Department of Scientific and Industrial Research,
Wellington, New Zealand.
June 8.

[1] Hilditch, T. P., "The Chemical Constitution of Natural Fats", 8, 2nd edit. (Chapman and Hall, London, 1947).
[2] Hansen, R. P., Shorland, F. B., and Cooke, N. J., *Nature*, [**174**, 39 (1954)].
[3] Hansen, R. P., and McInnes, A. G., *Nature*, [**173**, 1093 (1954)].

Basic Amino-acids of Silk Fibroin

IN studies of the constitution of proteins, the basic amino-acids are of particular interest. With silk fibroin, for example, the basic amino-acids are the least frequent of the constituent amino-acid residuee and are therefore indicative of the approximats minimum molecular weight. Coleman and Howitt[1] deduced from the available analytical data that, assuming the molecule to contain one histidine residue, there was present a total of some 390 residues which, accepting the experimental mean residue weight of 78, implied a molecular weight of approximately 30,000; a molecular weight of this order was found by osmotic pressure measurements made on the renatured protein. In the latter connexion, however, Holmes and Smith[2], by ultracentrifuge and diffusion methods, found a mean molecular weight of 60,000–150,000 (average 84,000) for water-soluble fibroin. This higher value of the mean molecular weight suggests that, assuming no great error to exist in the value of about 0·4 per cent for the histidine content of fibroin, there are at least two histidine residues in the fibroin molecule. In order to strengthen the available experimental evidence on this point, a careful determination has been made of the basic amino-acids in silk fibroin.

A sample of degummed silk (*Bombyx mori*) was exhaustively extracted with the azeotropic mixture of benzene and methanol, repeatedly washed with distilled water, and finally air-dried. Two samples of about 1·0 gm. were accurately weighed and hydrolysed by refluxing with 25 ml. of 5 *N* hydrochloric acid for 24 hr.; a third sample was examined for moisture content. Hydrochloric acid was removed from each of the hydrolysates by distillation *in vacuo* and the residue made up to 10 ml. with distilled water. Aliquots (0·20 ml.) equivalent to 20 mgm. of the original silk fibroin were fractionated on a 0·9 cm. × 15 cm. 'Dowex 50' ion-exchange resin column under the conditions described by Moore and Stein[3] for the separation of basic amino-acids, 2 ml. fractions being

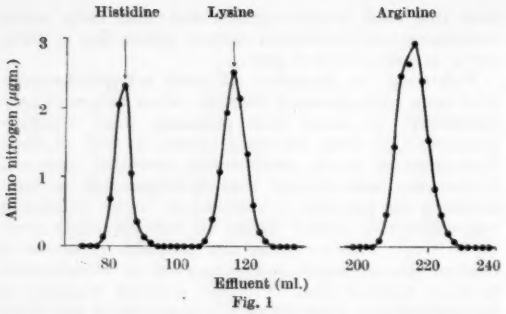


Fig. 1

collected. The histidine, lysine and arginine peaks thus obtained are shown in Fig. 1; the ammonia peak appearing between lysine and arginine was not estimated.

Two determinations were made on each of the two hydrolysates and gave the following values (corrected to a dry protein basis):

	Amino-acid (gm.)/100 gm. of fibroin
Histidine	0·370 ± 0·008
Lysine	0·537 ± 0·006
Arginine	1·000 ± 0·007

These values correspond (within ± 4 per cent) to an integral molecular ratio of 2 : 3 : 5, and indicate that the molecular weight of fibroin is of the order of 84,000 and that the number of amino-acid residues in the molecule is slightly greater than 1,000 (for an equivalent residue weight of 78); this agrees with the value for the molecular weight found by Holmes and Smith[3].

M. C. Corfield
F. O. Howitt
A. Robson
Wool Industries Research Association,
Torridon,
Headingley, Leeds 6.
June 15.

[1] Coleman, D., and Howitt, F. O., *Proc. Roy. Soc.*, A, **190**, 152 (1947).
[2] Holmes, F. H., and Smith, D. I., *Nature*, **169**, 193 (1952).
[3] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **192**, 665 (1951).

Olefinic Nature of Anacardic Acid from Indian Cashew-nut Shell Liquid

Anacardic acid, the major component of the liquid extracted by solvent from cashew-nut shells[1], was regarded as a homogeneous chemical entity containing in its aliphatic side-chain of fifteen carbon atoms two double bonds until recently, when it was shown by Izzo and Dawson[2] to be in fact a mixture of olefinic components of which they identified the mono-olefin in the form of a crystalline glycol of the methylated anacardic acid. The present communication reports the complete separation of the mixture into its several components and the determination of their olefinic structure.

A sample of anacardic acid, prepared from Indian cashew-nut shells, was subjected to fractional crystallization, using as solvents acetone, methanol and petroleum ether, at temperatures of 0° to − 80° C., whereby pure specimens of four components were isolated, namely, a saturated one, and a mono-, di- and tri-olefin.

The saturated component (m.p. 91·5° C.)[3] was identified as 1-hydroxy 2-carboxy 3-pentadecyl benzene, from a mixed melting-point determination with a pure sample of the compound obtained by catalytic hydrogenation of anacardic acid and carbon-hydrogen analysis.

Oxidation of the mono-olefin (m.p. 44–45° C.) with potassium permanganate in acetone gave azelaic, heptylic and oxalic acids, from which its structure was deduced as 1-hydroxy 2-carboxy 3-(8′ pentadecenyl) benzene, identical with the olefinic structure reported previously[2].

The di-olefin (m.p. 25–26° C.) on oxidation with permanganate in acetone at − 20° C. gave azelaic, butyric and oxalic acids. Further, the monophenol obtained by decarboxylation of the acid at low pressure, on methylation and subsequent oxidation with permanganate, yielded ω-(3-methoxy phenyl) caprylic acid[4,5], and butyric and oxalic acids. From these results, the di-olefin was assigned the structure 1 - hydroxy 2 - carboxy 3 - (8′,11′ pentadecadienyl) benzene.

A similar oxidation of the tri-olefin yielded azelaic, oxalic and formic acids; the methyl ether of the decarboxylated sample resulted, on oxidation, in ω-(3-methoxy phenyl) caprylic acid, and oxalic and formic acids. Tests for presence of conjugated double bonds were negative. On the basis of these observations, the tri-olefin was given the structure 1-hydroxy 2-carboxy 3-(8′,11′,14′ pentadecatrienyl) benzene.

A comparison of these results with those obtained recently on the monophenol from commercial cashew-nut shell liquid[5] points to the identity of the olefinic characteristics of the solvent-extracted and the commercial liquids. The composition of the heterogeneous mixture of the anacardic acid studied by us was found, on the basis of a typical careful fractionation, to be: saturated component, 4; mono, 15; di-, 44; and tri-olefin, 37 per cent.

A full account of this investigation will be published elsewhere.

V. J. Paul
Lourdu M. Yeddanapalli
Department of Chemistry,
Loyola College, Madras.
June 9.

[1] Staedeler, *Ann.*, **63**, 137 (1847).
[2] Izzo, P. T., and Dawson, C. R., *J. Org. Chem.*, **14**, 1039 (1949).
[3] Backer, H. J., and Haack, N. H., *Rec. Trav. Chim.*, **60**, 661 (1941).
[4] Paul, V. J., M.Sc. thesis, University of Madras (1951).
[5] Symes, W. F., and Dawson, C. R., *J. Amer. Chem. Soc.*, **75**, 4952 (1953).

Bacterial Soft Rot of Avocado Fruit

Soft-rot diseases of avocado fruit are recorded in the literature as associated with fungi. So far, the only bacterial disease reported to affect avocado fruit is a dry rot caused by *Pseudomonas syringae* Van Hall[1]. In December 1953, however, a bacterial soft-rot disease in avocado fruits was found in Israel on several fruits picked from a single tree of the Californian variety, H. L.

In infected specimens of unripe, hard, green fruits a third or more of the fruit area had been turned dark and soft by a spreading decay. The flesh underlying such areas was soft, light to dark-brown in colour, and smelled putrid. Microscopic examination of Gram-stained affected tissues revealed numerous Gram-negative rod-shaped bacteria.

The organisms were isolated in pure culture on nutrient agar + 1 per cent glycerol plates and a distilled water suspension of 48-hr. old slant cultures

was made. Healthy unripe fruits were inoculated by pricking through drops of the suspension placed on the fruit surface, and were kept in bell-jars over water at temperatures of 14–37° C. Within four to eight days, inoculated fruits developed lesions similar to those found on the original specimens. The lesions appeared as soft, dark, flat spots which spread far beyond the centre of inoculation. The spots coalesced and covered the entire fruit eight to nine days after inoculation at 32° C. Infection experiments with re-isolations from lesions gave similar results. No infection resulted when drops of suspension were not pricked into the fruit. Controls pricked through drops of sterile distilled water did not develop any sort of infection. Various vegetables inoculated with the organism under laboratory conditions developed a typical soft rot of the parenchyma; no infection was induced on avocado leaves, or on lemon fruits.

The organism is closely related morphologically, physiologically and pathologically to the group of organisms originally identified as *Erwinia aroideae* (Townsend) Holland[2], and later identified by Rudd Jones, Dowson and others as a non-gas-forming strain of *Bacterium carotovorum* (L. R. Jones) Lehmann and Neumann[3], or *Erwinia carotovora* (Jones) Holland[2]. Like other organisms of this group, it is a wound parasite and requires relatively high humidity to induce infection. Its optimal growth and pathogenicity temperature is 30–32° C.; no infection occurs above 38° or below 12° C.; good, though slow, infection is induced at 14° C., and very good infection is produced at 36–37° C.

A detailed report on this organism and on other isolates of *E. carotovora* and *E. atroseptica* (Van Hall) Jennison will be published elsewhere.

ZAFRIRA VOLCANI

Division of Plant Pathology,
Agricultural Research Station,
Rehovot, Israel.
April 22.

[1] Elliott, C., "Manual of Bacterial Plant Pathogens", 2nd edit. (1951).
[2] Bergey, D. H., Breed, R. S., Murray, E. D. G., and Parker-Hitchens, A., "Bergey's Manual of Determinative Bacteriology" (1948).
[3] Rudd, Jones, D., *Trans. Brit. Mycol. Soc.*, **33**, 73 (1950).

'Browning' Reactions in Freeze-dried Extractives from the Skeletal Muscle of Codling (*Gadus callarias*)

TARR[1–3] has shown that the 'browning' of flesh observed in many Canadian fish species when autoclaved for 1 hr. at 120° C. results from a Maillard reaction[4] between the various muscle amino-compounds and reducing sugars—primarily ribose. The present communication reports a study on the 'browning' of extract preparations of codling muscle under milder conditions such as are encountered during vacuum contact plate drying of fillets[5], dry salting and the storage of dehydrated codling muscle.

Codling muscle (1 hr. post mortem at 15° C.) was repeatedly extracted into cold 75 per cent v/v ethanol. Chloroform was added to the filtered extract to 75 per cent v/v and the emulsion shaken for ten minutes. After separation the upper, aqueous layer was freeze-dried. This preparation contained more than 90 per cent of the free amino-acids[6] and 70 per cent of the muscle reducing substances as determined by copper reduction. (Parallel chloroform separations of hexose and pentose sugar solutions in 75 per cent ethanol gave freeze-dried preparations with recoveries of the same order as amino-acids.) The white, deliquescent powder was ground at − 30° C. and stored over phosphorus pentoxide under high vacuum at 0° C. A yield of 1·9 per cent powder was obtained: nitrogen content, 13·72 per cent; reducing activity, 1·60 per cent glucose equivalent.

The nitrogenous fraction was found to include (nitrogen basis, per cent in powder): creatine + creatinine, 6·2; trimethylamine oxide, 3·2; taurine, 1·7; anserine, 0·98; volatile amine, 0·365; aspartic acid, 0·041; glutamic acid, 0·055; glycine, 0·24; serine, 0·026; α-alanine, 0·10; β-alanine, 0·051; lysine, 0·061; histidine, trace; 1-methylhistidine, 0·062; proline, trace; valine, 0·020; leucine, 0·033; cysteic acid, 0·05; glutathione, trace; phosphorylethanolamine, trace; glucosamine, trace; tyrosine, trace; threonine, trace. Chromatography failed to detect free ribose. Traces of glucose, glucosamine and another compound, probably galactose, were found, but most of the reducing substances remain to be identified. Few observations are available on phosphorylated glycolysis intermediates in fish muscle, and some of these are probably implicated. Tarr[1] has shown that addition of hexose phosphates increases browning in fish muscle at high temperatures.

Effect of water relations on browning. Tubes containing 20 mgm. freeze-dried extractives were equilibrated[7] in bottles of different relative humidities over a complete range given by phosphorus pentoxide, sulphuric acid – water mixtures and water. Such systems turned first pink and then brown in colour, changes strictly analogous to those found in intact fillets dried during storage. Fig. 1 illustrates typical effects of relative humidity and temperature on browning as estimated by the optical densities of diluted reaction-mixtures at 430 mμ. In the experiment at 25° C., the overall reaction series had not proceeded so far as those at 60° C., which gave poorer definition at 'peak' level but showed a marked shift of peak towards higher relative humidities. At both temperatures the peak was at a lower relative humidity than the 70 per cent reported by Lea and Hannan[7] for simple glucose–casein mixtures. Fig. 2 illustrates a 'browning' nitrogen concentration curve calculated from water uptake/relative humidity data obtained in other 60° C. experiments at a 100 mgm. extractive level. An extension for lower concentrations was obtained from experiments with extractive

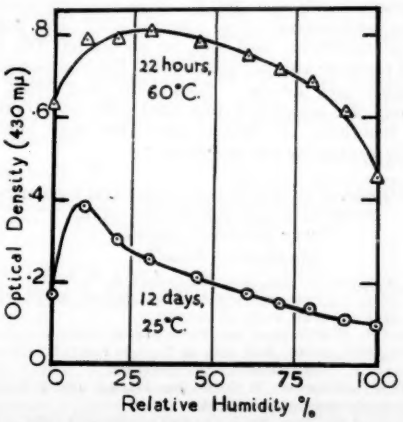


Fig. 1. 'Browning' at different relative humidities

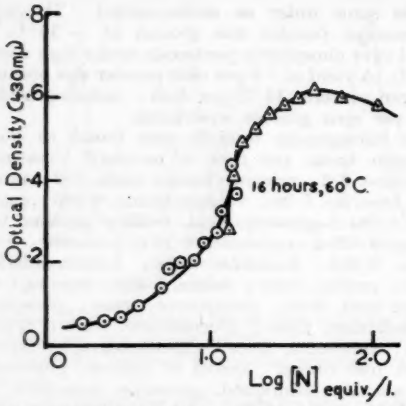


Fig. 2. 'Browning' at different concentrations of reactants

solutions at the same temperature and time in sealed tubes. This form of curve appears to be of greater value in relation to implications for the browning of whole fish than those in Fig. 1, as the linear uptake/relative humidity relation found for extractives differs appreciably from a sigmoid curve reported for intact muscle[8].

Effect of temperature. Aliquots of freeze-dried extractive solution (0·69 NN), with a drop of chloroform to inhibit bacterial growth, were allowed to react in sealed tubes at different temperatures. Table 1 shows that 'browning' is highly dependent on temperature under these conditions. Figures relate to the initial linear sections of 'browning'/time curves.

Table 1. 'Browning' at Different Temperatures

Temperature (° C.)	Units optical density increase/hr.
0°	$2{\cdot}97 \times 10^{-5}$
15°	$6{\cdot}30 \times 10^{-4}$
37°	$2{\cdot}00 \times 10^{-3}$
60°	$3{\cdot}01 \times 10^{-1}$

These figures give an approximately linear plot for $\log_{10}$ 'browning' rate/reciprocal absolute temperature.

Effect of pH. Solutions of the preparation had a pH of 6·8 and were strongly buffered. This accounted for the percentage 'volatile' amine held in salt form. Preliminary results indicate that 'browning' is at a maximum at pH 7 at 60° C. This has not been the finding with simple sugar – amino-acid[9] and sugar – protein[7] mixtures, and can be accounted for by a loss of reactive volatile amine from the reaction phase at higher pH levels. Such behaviour may well represent an important practical difference between such reactions of simple mixtures and complex volatile amine-containing systems.

N. R. Jones
Department of Scientific and Industrial Research,
Food Investigation Organization,
Torry Research Station,
Aberdeen. June 11.

[1] Tarr, H. L. A., *J. Fish. Res. Bd. Canada*, **8**, 74 (1950).
[2] Tarr, H. L. A., Prog. Rep. Pacific Coast Stations, **92**, 23 (1952).
[3] Tarr, H. L. A., *Food Tech.*, **8**, 15 (1954).
[4] Maillard, L. C., *C.R. Acad. Sci., Paris*, **154**, 66 (1912).
[5] Hamm, W. S., *Comm. Fish. Rev.*, **9**, No. 2, 1 (1947).
[6] Awapara, J., *Arch. Biochem.*, **19**, 172 (1948).
[7] Lea, C. H., and Hannan, R. S., *Biochim. Biophys. Acta*, **3**, 313 (1949).
[8] Jason, A. C., *Research*, **7**, 10 (1954).
[9] Wolfrom, M. L., Kolb, D. K., and Langer, jun., A. W., *J. Amer. Chem. Soc.*, **75**, 3471 (1953).

Uptake of Phosphorus-32 by Mycorrhizal Plants

Investigations based on chemical analyses have indicated that the absorption of phosphorus by pine seedlings is increased by the presence of ectotrophic mycorrhizas[1]. Harley *et al.*[2] have shown, however, that when labelled phosphorus is supplied to excised roots of beech the presence of a mycorrhizal sheath presents a partial barrier to phosphorus uptake by the tissues of the root. This communication reports the result of an experiment in which phosphorus-32 was used to indicate how far the mycorrhizal habit influences the uptake of phosphorus by intact plants of *Nothofagus menziesii* (mycorrhizas ectotrophic, typical of the Fagaceae) and *Pinus radiata*. The presence of mycorrhizas had no apparent effect on the rate of growth of these two species under the conditions employed in the experiment.

Individual mycorrhizal and non-mycorrhizal seedlings were transplanted in February, 1954, into separate glass pots containing 360 gm. (moist weight) of a chemically sterilized meadow loam of pH 5·3, known to be deficient in phosphates. Six weeks later all the plants were supplied with radioactive phosphorus. This was added to the soil as 200 ml. of a solution in distilled water. Two concentrations were employed to give activities of 50 μc. and 100 μc. per pot, respectively. After fourteen days the leaves of the plants were assayed for relative activity.

For each of the two species, comparable samples of leaf tissue were obtained by taking equal numbers of leaf segments (thirty segments, 2 cm. in length) in *Pinus*, or equal numbers of leaf disks (twelve disks, 5 mm. in diameter) in *Nothofagus*, from the upper leaves of the plant. The leaf segments or disks, representative of each plant, were arranged beneath an end-window Geiger–Müller counter connected to a 'Dynatron' electronic scaling unit.

Table 1. Relative Activity (in counts per minute) of Leaf Samples from Mycorrhizal and Non-mycorrhizal Plants supplied with Phosphorus-32

Phosphorus-32 per pot	*Pinus*		*Nothofagus*	
	Mycorrhizal	Non-mycorrhizal	Mycorrhizal	Non-mycorrhizal
50 μc.	59	11	7	41
	457	0	64	1
	138	9	22	0
	765	0	95	28
	536	1	18	44
		0		
100 μc.	1,003	12	293	64
	215	13	8	0
	193	2	199	26
	879	1	28	72
	1,584	5	37	61
		3		

Table 1 shows that in *Pinus*, despite the variability between plants, the leaves from the mycorrhizal plants were, without exception, markedly more active than those from non-mycorrhizal plants. In *Nothofagus*, however, no similar consistent difference was observed. The results indicate that the mycorrhizal habit enhanced the uptake of phosphorus to the leaves in seedlings of *Pinus*, while exerting relatively little influence on this process in seedlings of *Nothofagus* grown under the same conditions.

I wish to thank Mr. H. D. Jamieson and Dr. G. P. Harris for help and advice, and the Department of Physics, University of Otago, for facilities provided in making the counts. Financial assistance was

given by the University of New Zealand Research Fund.

T. M. Morrison

Department of Botany,
University of Otago,
New Zealand. May 4.

[1] Hatch, A. B., *J. Forestry*, **34**, 22 (1936). Mitchell, H. L., Finn, R. F., and Rosendahl, R. O., *Black Rock Forest Papers* **1**, 58 (1937).
[2] Harley, J. L., and McCready, C. C., *New Phytol.*, **51**, 56 (1952). Harley, J. L., Brierley, J. K., and McCready, C. C., *New Phytol.*, **53**, 92 (1954).

Antagonist Inhibition as the Earliest Sign of a Sensory-Motor Reaction

Reaction time is defined as the interval of time between a sensory (optic, acoustic, tactile, etc.) stimulus and the voluntary reaction of muscular contraction. The values of reaction time for a given sensory-motor reaction show the smallest variation when the subject is alertly expecting the sensory stimulus. Even so, there is considerable variation of reaction time between different subjects. Individual differences are of less interest, however, than the lowest value of reaction time obtainable in optimal circumstances if the minimum time of cortical integration for a sensory-motor reaction is to be studied. The time of cortical integration is obtained by subtracting the afferent and efferent conduction times from the reaction time[1].

So far, only the electrical or mechanical manifestations of muscular contraction in agonists have been studied as examples of voluntary reaction[2]. We have undertaken a study of the simultaneous changes in muscles antagonistic to the voluntary movement of the reaction.

In our experiments, the sensory stimulus was evoked by an electric shock to the N. medianus in the fossa cubiti, of a strength which gave only a tactile perception. The electrical activity of the

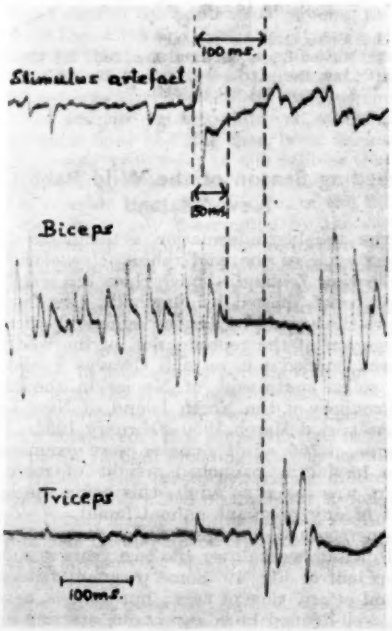


Fig. 1

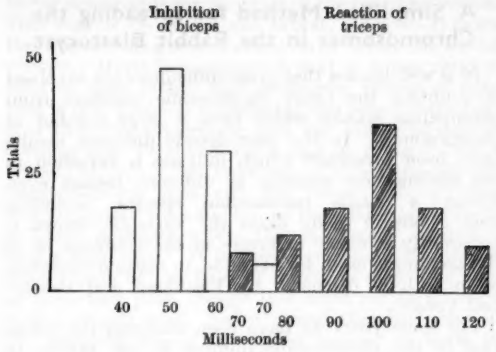


Fig. 2

M. biceps and triceps of the same arm were separately recorded by means of an electroencephalogram apparatus (Schwarzer). The subject held his M. biceps in strong tonic contraction and reacted to the sensory stimulus by a contraction of his M. triceps.

With this arrangement, the voluntary reaction of triceps contraction was usually preceded some 50 m.sec. earlier by inhibition of the tonic biceps contraction (Fig. 1). Fig. 2 shows in diagrammatic form the reaction times for antagonist inhibition and agonist contraction. The reaction time for antagonist (biceps) inhibition may be as short as 40 m.sec.—a surprisingly low value if the reaction is accepted as being cortically integrated (voluntary). The antagonist reaction could scarcely be an example of spinal reciprocal inhibition[3]; it is interpreted by us as part of the voluntary reaction, although the actual inhibitory influence may be exerted at the cortical or spinal level.

The afferent conduction time from the peripheral nerve to the sensory-motor cortical area has been estimated as about 18 m.sec. (after Dawson[4]). The efferent conduction time, from the motor cortex to the peripheral muscle, has been estimated as at least 12 m.sec., due regard being taken to interneuronal spinal transmission (Lloyd[5], cf. ref. 6). By subtraction, an interval of only 10–20 m.sec. is left for cortical integration of the reaction of antagonist inhibition. This time interval is of the same order of magnitude as the duration of an 'evoked potential'[7].

The present observations therefore indicate that even a voluntary sensory-motor reaction may take place within restricted cortical fields without necessarily engaging more complicated cortical or subcortical reverberating circuits.

A detailed description of the results will appear in the *Zeitschrift für Biologie*. The investigation was supported by a grant from the Deutsche Forschungsgemeinschaft.

H.-J. Hufschmidt
Tamara Hufschmidt

Physiological Institute and Neurological Clinic,
University of Munich.
May 5.

[1] Monnier, M., *Helv. Physiol. Acta*, **7**, c52 (1949).
[2] Wirth, W., "Die Reaktionszeiten", 525–598, in "Handbuch der normalen und pathologischen Physiologie", **10** (Berlin, 1927). Bernhard, C. G., *Acta Physiol. Scand.*, **1**, Supp. 1 (1940).
[3] Sherrington, C. S., *Proc. Roy. Soc.*, B, **76**, 160 (1905).
[4] Dawson, G. D., *J. Neurol., Neurosurg. and Psychiat.*, **10**, 134 (1947).
[5] Lloyd, D. P. C., *J. Neurophysiol.*, **4**, 525 (1941).
[6] Bernhard, C. G., *Acta Physiol. Scand.*, **29**, Supp. 106, 79 (1953).
[7] Whitteridge, D. "Physiology", 92–166, in "Electroencephalography", edit. by D. Hill and G. Parr (Macdonald, London, 1950). Eccles, J. C., *EEG and Clin. Neurophysiol.*, **3**, 449 (1951).

A Simplified Method for spreading the Chromosomes in the Rabbit Blastocyst

It is well known that great difficulties are involved in counting the exact chromosome numbers from mammalian species which have a large number of chromosomes. In the past decade different results have been presented which indicate a variation in the chromosome number in different tissues even within a single mammalian species, including man[1]; but in many cases the variation shown is apparently a result of errors in the counting or in the technique used, for example, in making squashes, or in both as discussed by Fischberg and Beatty[2] and Venge[3].

For some years we have been studying the variation in the chromosome number in the rabbit, in testicular tissue as well as in blastocysts. During the course of the experiments it became clear that much of the variation in the chromosome number was due to counting errors if only gentle squashes were applied; but if the squash was made with a high pressure in a vice, mechanical disturbances were introduced[3]. We therefore tried to find a method of spreading the chromosomes without breaking the cells.

Continuing our experiments, we treated rabbit blastocysts in saline solutions of different concentrations for twenty minutes at a temperature of $37° \pm 1°$, with the result that many more cells could be used for counting the number of chromosomes (Table 1).

Table 1. Number of Cells Counted in Treated Blastocysts

Concentration of sodium chloride	0	0·30	0·45	0·67	0·90 per cent
No. of blastocysts	2	19	44	27	24
No. of cells counted	1	186	425	147	21
No. of cells per blastocyst	(0·5)	9·8	9·7	5·4	0·9

We are aware that subjectivity enters into the decision whether a cell should be counted or not. However, once the decision was made, the cell was used in the chromosome counts. The results indicate the increase in number of countable cells due to our method.

By the treatment in the hypotonic solution and applying squash in making the preparation the spindle is disturbed; but the split between the chromatids is not so exaggerated as described by Manna[4]. In Fig. 1 is shown a metaphase plate where the chromosomes are well spread due to treatment of the blastocyst in 0·45 per cent solution. Only a gentle squash was applied. The chromosome number (44) is easily counted. The risk of producing artefacts is in our experience very small. In addition, the staining of the chromosomes is often better than with untreated blastocysts. The main result is therefore that a higher number of cells can be counted with greater exactitude.

Treatment in water (0 per cent sodium chloride) was only carried out with two blastocysts, as it immediately became clear that most of the metaphases pass on to ana- or telo phase. By treating the blastocysts in common physiological saline solution only one cell per blastocyst, approximately, could be used. The best results are obtained by using a 0·45 per cent saline solution, but next to this comes the 0·67 per cent despite the lower number of cells per blastocyst. It is more difficult to handle the blastocysts which have been treated in a 0·30 per cent solution as the tissue becomes too soft. In all the treatments the time was kept constant at 20 min., the age of the blastocysts was five days after mating, the fixative was alcohol–acetic acid (3 : 1) and the staining was done according to the Feulgen method, with 6 min. hydrolysis at 60°.

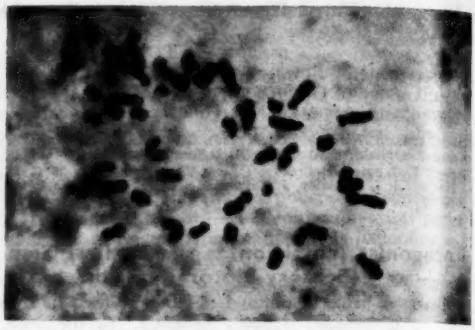


Fig. 1. Metaphase plate from a blastocyst treated in 0·45 per cent saline solution for 20 min. at 37° ($2n = 44$)

It should be mentioned that about 95 per cent of the cells have a chromosome number of $2n = 44$, which is the normal diploid number of the rabbit. However, a few cells have been found to be haploid, while others must be classified as polyploid cells with $3n$ or $4n$ chromosomes. Details of these chromosome numbers will be published elsewhere, when the experiments have been finished.

I am indebted to Mr. P. J. Åström for his help throughout the experiment.

Ole Venge

Institute of Animal Breeding,
Royal Agricultural College of Sweden,
Uppsala.
June 14.

[1] Sachs, L., *Nature*, **172**, 205 (1953).
[2] Fischberg, M., and Beatty, R. A., *J. Exp. Zool.*, **118**, 321 (1951).
[3] Venge, O., Ann. Roy. Agric. Coll., Sweden, **19**, 233 (1953).
[4] Manna, C. K., *Nature*, **183**, 271 (1954).

Breeding Season of the Wild Rabbit in New Zealand

Little reliable information is available on the breeding cycle of the wild rabbit (*Oryctolagus cuniculus*) in New Zealand, though there is a widely held popular belief, quoted by Marshall[1], that in certain localities the animal breeds throughout the year. An investigation of the reproduction of the wild rabbit has been carried out on the Gwavas Forest area, thirty miles south-west of Napier in the Hawkes Bay Province of the North Island of New Zealand over the period March 1950–February 1952. During this time, 1,766 adult females were examined: a female having a paunched weight of more than 700 gm. was taken as adult, this being the lightest weight of any pregnant animal found.

The percentage of adult females pregnant in each period of four weeks over the two years is shown in the top half of Fig. 1. Some pregnant females can be found at any time of year; but there is, nevertheless, a well-defined breeding season, starting in mid-winter (June) and lasting four or five months, when

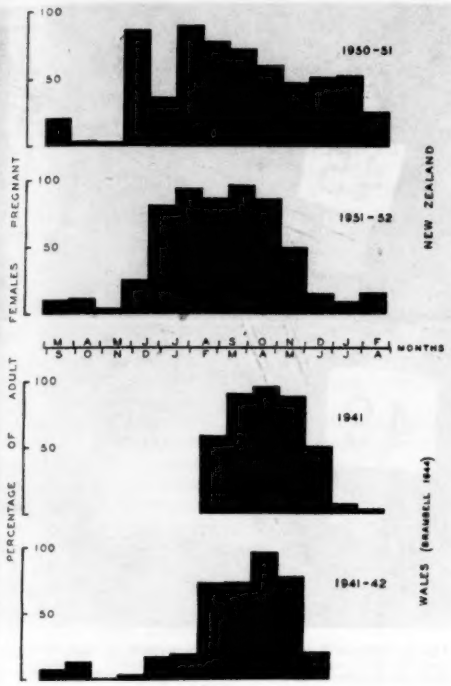


Fig. 1

reproductive activity is very high; but from February to May little breeding occurs. There were a number of quite marked differences between the two years; in 1950 the rabbits started breeding about a month earlier than in the following year, and the end of the breeding season was more drawn out, more than 50 per cent of the adult females being pregnant throughout December and January. It was suspected that many of the females breeding at this time had themselves been born earlier in the season; but the method that was later developed[2] for distinguishing fully grown animals of up to nine and a half months old from older ones had not then been worked out. In the following year most of the rabbits that were breeding at this time were less than nine months old; thus it is possible that the duration of the breeding season may be largely determined by the survival-rate in the early litters. The reduction in male fertility which brought to an end the breeding season in Wales[3] was not so apparent in Hawkes Bay.

Brambell[3] carried out a detailed investigation of the reproduction of the rabbit at Bangor in North Wales: in the lower half of Fig. 1 his figures have been grouped in four-weekly periods that correspond seasonally with the New Zealand ones, so that the variations in pregnancy-rate throughout the year can be directly compared. It is apparent that in Hawkes Bay the period of high breeding activity lasts longer than in Wales; and the most striking difference is in the time of onset, which occurs eight to ten weeks earlier. Other European mammals, particularly ruminants and ferrets, introduced into the southern hemisphere, adhere very closely to the corresponding breeding season[4].

In many spring-breeding animals the increasing length of daylight is supposed to be the proximate factor responsible for the start of the breeding season. This cannot be so for the rabbit, since in Hawkes Bay the breeding season starts on or before the winter solstice. Hart[5] has suggested that it is the ratio of light to dark rather than increasing planes of light that is important in stimulating the onset of œstrus; it is therefore interesting that the length of day at Gwavas (lat. 40° S.) in June, and at Bangor, North Wales (lat. 52° N.) in February is approximately the same—between nine and ten hours; though this may be purely coincidental, as the rabbit also breeds in lower latitudes where the day-length is always longer than this. It is, however, likely that other factors such as the level of nutrition may also play an important part, though this could not be assessed in the present case. Baker[6] found that the onset of the breeding season in related species of birds in temperate regions tended to be twenty to thirty days earlier for each ten degrees of latitude towards the equator; similarly with sheep[7], the breeding season tends to start earlier and last longer in lower latitudes. It is therefore possible that the rabbit may be found to have a similar pattern.

A detailed account of this investigation on the reproduction of the rabbit in New Zealand is being prepared for publication.

J. S. Watson

Animal Ecology Section,
Department of Scientific and Industrial Research,
Wellington, New Zealand.
June 2.

[1] Marshall, F. H. A., *Proc. Roy. Soc.*, B, **122**, 413 (1937).
[2] Watson, J. S., and Tyndale-Biscoe, C. H., *N.Z. J. Sci. Tech.*, B, **34**, 427 (1953).
[3] Brambell, F. W. R., *Proc. Zool. Soc. Lond.*, **114**, 1 (1944).
[4] Marshall, F. H. A., *Biol. Rev.*, **17**, 68 (1942).
[5] Hart, D. S., *J. Exp. Biol.*, **28**, 1 (1951).
[6] Baker, J. R., *Proc. Zool. Soc. Lond.*, A, **108**, 557 (1938).
[7] Hafez, E. S. E., *J. Agri. Sci.*, **42**, 189 (1952).

Environmental Control of Coat Changes in Cattle

Cattle of European origin usually possess a long, woolly coat of hair in the winter; in spring the long hairs are shed and by summer the coat is smooth and sleek. These seasonal changes occur with great regularity, and as they are an aid to the animal in preserving thermoneutrality, it is commonly supposed that they are regulated by environmental temperature.

However, regulation through a photoperiodic mechanism is suggested by the fact that coat changes in the mink[1], fox[2], and horse[3] are now known to be influenced by light. Further, Laing[4], using increased light during winter in England to stimulate œstrus in cattle, noted a tendency for shedding of the hair to occur.

In the absence of definite knowledge on the matter, an experiment was designed and is now in progress at the Physiology Department, University of Queensland, to test the possible importance of light in regulating seasonal coat changes in cattle.

Eight Poll Shorthorn calves, aged two weeks to two months, were divided into two similar groups, control and experimental, of four animals each. After a six-week period of conditioning to their surroundings and feed, the experiment, involving for the

experimental group complete reversal of the seasonal trend of daylight hours, commenced on February 2, 1954.

Each group occupied a separate stall but was similarly treated except for the daily quota of light provided. The control stall was open to natural daylight and, as no other light was allowed, the calves in it received the daily duration of light normal for the latitude of Brisbane. This amounted to just over 14 hr. of light a day at the start, the level decreasing gradually with the approach of winter to just over 11 hr. at the time of writing (June 7). The experimental stall was also open to daylight, but in it day-length could be either shortened, using black-out arrangements, or increased by switching on four 250-watt electric lights in the evening and early morning. Using these facilities, the experimental calves were started in the experiment at a daily light-level of a little more than 10 hr. This was raised gradually, changes being made weekly, to the present level of 16½ hr. Thus the experimental calves were placed on an increasing plane of light while the controls received decreasing light.

Temperature differences in the two stalls have at no time exceeded 3° F. All eight calves have increased in weight at a similar satisfactory rate.

Monthly hair samples have been taken from separate standard areas of skin on the flank for use in the quantitative assessment of any changes. Photographic records have also been made.

The first effect of the experimental treatment became apparent on May 5, three months after the start of the experiment, when, during the hair sampling, it was noticed that swathes of long hair could be rubbed off the neck and shoulders of the experimental calves. This process of shedding has continued in all four calves of the experimental group. Their heads and necks are now smooth and glossy, and the shedding is extending posteriorly.

The hair of the control calves, on the other hand, is firmly attached and the coats of these animals have become long and woolly, typical of the appearance to be expected with the approach of winter. These visible changes are reflected quantitatively by the monthly hair sampling results (see Fig. 1).

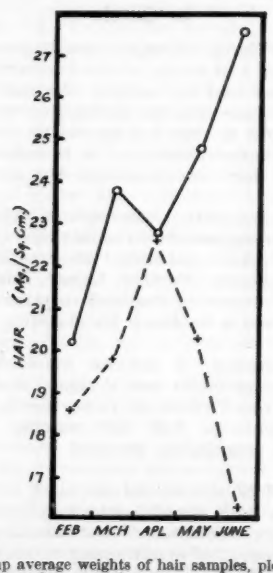


Fig. 1. Group average weights of hair samples, plotted for each month. —O—, control; – – – + – – –, light treated

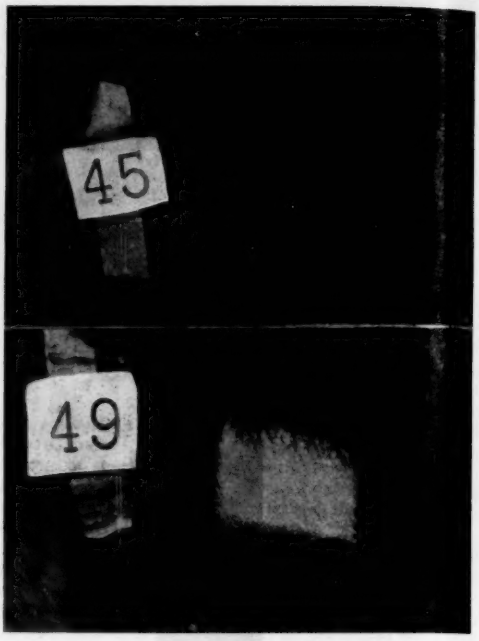


Fig. 2. Regrowth of hair on square patches of skin which had been clipped bare 20 days previously is greater on control (45) than on experimental calf (49). Photographs taken on May 25, 1954

Another point now noticeable is that on the areas of skin from which recent monthly hair samples have been clipped, the experimental calves have grown less hair than the controls (see Fig. 2).

From the results so far available, it is clear that the light environment exercises an important influence on the seasonal coat changes of cattle. A rising plane of light initiates shedding of long hairs and, with cattle of the type used in this experiment, shedding commences after approximately twelve weeks of increasing light. Growth of new hair also appears to be less on a rising plane of light than it is in decreasing light.

This experiment forms part of an inquiry into adaptation of cattle to tropical environments being undertaken co-operatively by the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, and the Department of Physiology, University of Queensland. Thanks are due to Prof. W. V. Macfarlane for advice and encouragement.

N. T. M. Yeates

Commonwealth Scientific and
Industrial Research Organization,
and
Physiology Department,
University of Queensland,
Brisbane.
June 7.

[1] Hammond, jun., J., *Nature*, **167**, 150 (1951).
[2] Ritchie, G. R., *Anim. Breed. Abstr.*, **20**, 109 (1952).
[3] Burkhardt, J., *J. Agric. Sci.*, **37**, (1), 64 (1947).
[4] Laing, J. A. (personal communication, 1948).

Production of Worm-free Lambs at Pasture

Recent research has shown that a considerable loss of productivity occurs in sheep carrying a sub-clinical infestation of nematodes parasitic in the alimentary tract[1,2]. This work has depended upon comparisons of worm-free and lightly infected groups of animals and has therefore been carried out in indoor pens. It has been concluded that infected sheep gain weight at less than their optimum rate; but it is not clear how valid these results are for sheep at pasture, under normal conditions of continual reinfection by grazing. In order to measure the actual loss due to sub-clinical parasitism it is necessary to compare normally infected sheep with similar, worm-free animals under grazing conditions. An investigation was therefore carried out during March–July 1954 at the Grassland Research Station, Stratford-on-Avon, into the possibility of raising worm-free lambs at pasture.

As previously indicated[3], two essential requirements are (*a*) a worm-free pasture and (*b*) a grazing management capable of preventing infection of the lambs from their infected ewes.

The pasture used was a newly sown ley following two successive corn crops. The land had not been grazed by either sheep or cattle for two years. The grazing management adopted was based on the fact that the majority of the nematode eggs passed in the fæces of the host do not reach an infective larval stage for at least three days.

Nine ewes and fifteen lambs were transferred to the pasture when the lambs were less than twenty-four hours old and folded over it, using movable fences. The animals were moved in such a way that they never remained on the same area for more than two days and were never pastured on a previously grazed area. Regular fæcal egg-counts were carried out on both the ewes and lambs, 5–10 gm. samples being taken. The average egg-count for the ewes during this period was 300 eggs per gm. No anthelmintic was administered to either ewes or lambs during the time these were in the experiment.

The lambs were weaned at fifteen weeks and their egg-counts at this time were as follows: No eggs of *Nematodirus* spp. were found at any time; two lambs had counts of 2 and 1 *Trichuris ovis* eggs per gm., respectively; five lambs had negative counts for *Strongyloides papillosus*, and of the remainder 12 eggs per gm. was the highest count; the counts for 'other strongyles' were negative for twelve lambs and 1, 3 and 27 eggs per gm. respectively for the remaining three animals.

During the first thirteen weeks only an occasional *T. ovis* egg and low counts for *S. papillosus* were recorded. One lamb appeared to acquire a slight infection shortly before weaning. The complete absence of 'other strongyle' eggs in twelve of the lambs shows that it is possible to raise 'worm-free' lambs in the field. The negligible counts for other species compare favourably with 'worm-free' lambs raised in indoor pens. For comparison, an equivalent group of ewes and lambs were grazed on the re-growth of pasture following the first group and managed in a similar manner on such infected pasture.

It may be noted that at weaning time the average egg-count (excluding *S. papillosus*) of these lambs was 90 eggs per gm. Their peak of 400 eggs per gm. was reached in June, at which time they were dosed with phenothiazine. The worm-free lambs gained weight more rapidly than the sub-clinically infected animals.

The experiment has confirmed that a ley sown on land ungrazed for two years is worm-free. The possibility of retaining 'worm-free' ewe lambs and maintaining them as a 'worm-free' breeding unit, and the effect of age on the development of resistance to infection, are under investigation.

C. R. W. Spedding

Grassland Research Institute,
Hurley, Berkshire.

[1] Gibson, T. E., *State Vet. J.*, **6**, 22 (1951).
[2] Spedding, C. R. W., *Empire J. Exp. Agric.*, **21**, (84), 255 (1953).
[3] Spedding, C. R. W., *Agric.*, **61**, 51 (1954).

Normal Hæmatological Values in the Buffalo

In view of the wide range in the characteristics of the blood constituents of various animals, an investigation has been carried out to determine the normal values for various blood constituents of the domestic buffalo (*Bos* (*Bubalus*) *bubalis*).

Twenty adult Egyptian buffalo-cows were available at the Animal Breeding Research Farm, Giza, Egypt. They ranged in age from three to ten years and were healthy and non-pregnant. Samples of oxalated blood were taken during the period January–April 1953. Red, white and differential counts were carried out and the diameter of the corpuscles was determined in dry stained smears. The following determinations were made: sedimentation-rate (using Westergren method), clotting time (Sabraz's capillary tubes), hæmoglobin content (Halden hæmoglobinometer), specific gravity (Weiss copper sulphate method), *p*H (Beckman *p*H meter) and the hæmatocrit (using the Winthrop technique). The following chemical constituents were also determined: blood sugar (Folin and Wu method), plasma proteins and non-protein nitrogen fraction using a semi-micro Kjeldahl method (Van Slyke technique), sodium (Weinback's method), calcium (Roe and Kohn technique) and phosphorus (Fisk and Subba Row's method).

The erythrocyte count was $6{\cdot}8 \times 10^6$/mm.^{3}, while the leucocyte count was $6{\cdot}7 \times 10^3$/mm.^{3}. In a differential leucocytic count, the percentages of lymphocytes, neutrophils, monocytes, eosinophils and basophils were 51, 36, 8, 5 and less than 1 respectively. The average diameter of erythrocytes was 5·5 μ, while the diameters of lymphocytes, neutrophils, monocytes, eosinophils and basophils were 6·8, 11·3, 15·7, 11·8 and 11·8 μ respectively.

The physiological and chemical characteristics of buffalo blood are shown in Table 1.

In the buffalo, the erythrocyte count is higher than in cattle and lower than in sheep and horse, whereas the leucocyte count is less than in cattle, horse and sheep. The percentage of lymphocytes, monocytes and eosinophils (in the differential count) in the buffalo is higher than in sheep and horse and lower than in cattle. The percentage of neutrophils in the buffalo is less than in sheep and horse and higher than in cattle. The basophils have almost the same frequency (less than 1 per cent) in all farm animals. The sedimentation-rate in the buffalo is higher than in cattle and lower than in horse, while the hæmoglobin content is higher in the buffalo than in all other farm animals. The clotting time of buffalo blood is longer than in sheep, shorter than in horse and similar to that of cattle. In general, buffalo blood is characterized by a relatively (to other farm animals) high

Table 1. Physiological and Chemical Values of Buffalo Blood

Items	Unit	Range	Mean ± S.D.	C.V. %
Specific gravity	gm./ml.	1·05–1·07	1·058±0·012	1
pH		7·35–7·6	7·45 ±0·0382	0·5
Sedimentation-rate	mm./1 hr.	2–8	6·0 ±1·65	29
Clotting time	min.	6–7·25	6·75 ±0·065	1
Hæmoglobin	gm./100 ml.	11·04–15·18	12·98 ±1·236	10
Hæmatocrit	percentage	38–52%	44·3 ±3·028	7
Sugar	mgm./100 ml.	72–90	81·4 ±3·411	4
Plasma proteins	gm./100 ml.	6·82–7·62	7·43 ±0·266	4
Plasma non-protein nitrogen	mgm./100 ml.	25–42	36±3·142	8
Plasma sodium	mgm./100 ml.	400–430	415±6·53	2
Plasma calcium	mgm./100 ml.	9–11	10±0·156	2
Plasma phosphorus	mgm./100 ml.	26–31	28±1·032	3

content of sugar plasma proteins and phosphorus and low content of calcium and sodium.

The blood picture of the animal is a result of an interaction between environmental (mainly domestication) and hereditary factors. The blood picture of the Egyptian buffalo falls among that of the Kumeoni, Hariana and Dhanni breeds of the Indian buffalo reported by Kehar and Murty[1]. A comparative study of normal hæmatological values is of great significance in studying the origin and evolutionary trends of species and breeds; such studies are also of particular interest for practical animal husbandry in the tropics, since certain features may be correlated with heat tolerance, environmental stress and disease immunity.

Thanks are due to Prof. A. L. Badreldin, chairman of the Animal Breeding Department, Faculty of Agriculture, and to Dr. M. H. Maghraby, of the Ministry of Agriculture, for providing facilities and help.

E. S. E. Hafez
A. Anwar

Faculty of Agriculture,
University of Cairo.
June 14.

[1] Kehar, N. D., and Murty, V. N., *Ind. J. Vet. Sci. Animal Husb.*, **21**, 13 (1951).

In vitro Production of Tropical Black Earth

The term 'grumusol' was proposed by Oaks and Thorp[1] for the dark-coloured clays which occur in many tropical and sub-tropical regions. Much is known concerning the chemistry[2,3], mineralogy[4] and fertility[5] of a number of these soils; but, as pointed out by Joffe[6], "the source of the black colour has been a kind of an enigma".

During the course of an investigation into the origin of the colour of Gold Coast black Akuse clay, the following experimental approach was adopted. Experimental pedology (the production of characteristic soil types under controlled laboratory conditions) is still a neglected section of soil science, and apart from the *in vitro* production of podsols[7] there has been scarcely any published work on this approach. The success met with here has prompted us to publish the results obtained, in order to indicate the potentialities of the method for studying tropical soil formation.

The three substrates used were kaolin (white), Bunso clay (yellow-red), and Akuse clay from which the organic matter had been removed by heating to 600° C. (yellowish-brown). 40-gm. samples of each of these substrates were placed in a series of 12-oz. bottles. These were then amended so that all possible combinations of five variable factors were represented.

The factors were: (1) Presence of readily-decomposable organic matter: (*a*) 3 per cent finely ground *Vetiveria* grass (dominant species on Akuse clay); (*b*) no plant material added. (2) Presence of an inoculum of black Akuse clay: (*a*) 1 ml. of a 1 : 5 soil suspension added; (*b*) no inoculum added. (3) *p*H: (*a*) adjusted to *p*H 5 with 2 *N* hydrochloric acid; (*b*) adjusted to *p*H 8 with 0·25 *N* sodium hydroxide. (4) Presence of excess calcium carbonate: (*a*) 5 per cent calcium carbonate added; (*b*) no calcium carbonate added. (5) Water content: (*a*) substrate kept permanently waterlogged; (*b*) substrate saturated with water and then left to dry out; alternation of anaerobic and aerobic conditions repeated throughout the course of the experiment.

The bottles were kept at room temperature (22–35° C.) and the results recorded after six weeks. No colour changes occurred in the amended kaolin; but in both the red Bunso clay and the mineralized Akuse clay there developed under certain conditions the characteristic grey colour associated with 'grumusols'.

There were four essential conditions for the development of this colour in the mineralized Akuse; namely, the presence of plant material, a soil inoculum, alkaline reaction and waterlogging. The addition of calcium carbonate, however, had no effect.

For the colour to develop in red Bunso clay, alkaline waterlogged conditions and the presence of plant material were again essential. An inoculum of Akuse clay was unnecessary, indicating that the native microflora of the ferruginous clay is able to induce the colour change if the soil conditions are favourable. In the absence of added calcium, the grey zone in Bunso clay was small and ill-defined, indicating that calcium was involved in the production of the colour and that the lack of a response to added calcium carbonate in mineralized Akuse was due to the high calcium status already existing in the soil.

Grumusols develop in warm regions with well-defined wet and dry seasons[1]. Our results indicate that the dark colour of these soils is due to the activity of anaerobic bacteria which develop in the alkaline, poorly drained montmorillonitic clays during the wet season. This confirms the hydrogenic origin of tropical black clays, as suggested by the work of Mohr[8] and del Villar[9].

D. G. Hessayon
R. G. Hutton

Faculty of Agriculture,
University College,
Gold Coast.
June 9.

[1] Oaks, H., and Thorp, J., *Proc. Soil Sci. Soc. Amer.*, **15**, 347 (1951).
[2] Agarwal, R. R., and Mukerji, P., *Ind. J. Agric. Sci.*, **19**, 31 (1949).
[3] Raychaudhuri, S. P., Sulaiman, M., and Bhuiyan, A. B., *Ind. J. Agric. Sci.*, **13**, 264 (1943).
[4] Stephen, I., *J. Soil Sci.*, **4**, 211 (1953).
[5] Basu, J. K., and Kibe, M. M., *Curr. Sci.*, **15**, 131 (1946).
[6] Joffe, J. S., "Pedology" (New Jersey, 1949).
[7] Smirnov, V. P., *Ezhegod. Geolog. i Miner. Rossii*, **14**, 206 (1912).
[8] Mohr, E. C. J., "Soils of Equatorial Regions" (Michigan, 1944).
[9] del Villar, E. H., *Soil Sci.*, **57**, 313 (1944).

Pile Irradiation of Polyethylene Terephthalate ('Terylene')

In view of its bearing on the recent communication from Miss Little[1], some simultaneous and independent work, initiated by Charlesby's claim to have cross-linked polyethylene terephthalate by pile irradiation[2], is perhaps worth recording.

The solution viscosities of two ethylene terephthalate polymers, both before and after varying amounts of irradiation in the BEPO pile at the Atomic Energy Research Establishment, Harwell, were measured in *o*-chlorophenol at 25° C. One polymer ('microdull') contained titanium dioxide as a delustring agent but there was none in the other ('bright'). For both polymers, the limiting viscosity number $[\eta]$ fell and the Huggins's viscosity slope constant[3],

$$k^1_H = \frac{\mathrm{d}\left(\frac{\eta - \eta_0}{\eta_0 c}\right)}{\mathrm{d}c} \Big/ [\eta]^2,$$

where η and η_0 are the viscosities of solution and solvent respectively and c is the concentration of the solution in gm./ml., rose with increase of radiation dose. It should perhaps be noted that hydrolysis will contribute to the $[\eta]$ drop for the samples of bright polymer irradiated longest in sealed tubes if the temperature in the pile approaches 100° C.

Polymer	Radiation energy (MW. hr. × 10^2)	$[\eta]$	k^1_H
Microdull	0	76	0·25
"	0·3 in air	65	0·39
"	0·5 "	62	0·41
"	1·0 "	57	0·43
"	2·0 "	52	0·38
Bright	0	65	0·27
"	2 *in vacuo*	49	0·43
"	4 "	42	0·53
"	8 "	37	0·52

Although the exact significance of k^1_H is not clear, it is generally agreed that it depends on the interactions between the molecules in high polymer solutions: a rise in k^1_H would correspond to a reduction in the effectiveness of *o*-chlorophenol as a solvent for the polymer. The exponent α, which is thought to be unity for spinning-grade polyethylene terephthalate (W. R. Throssell, unpublished work), in the relation between $[\eta]$ and number average molecular weight $\overline{M}_n$, $[\eta] = K\overline{M}_n$, would also be expected to fall and cause a reduction in $[\eta]$ uncompensated by the accompanying rise in K. Hence, the observed drop in $[\eta]$ does not necessarily indicate a reduction in $\overline{M}_n$, although the magnitude of the effect suggests that this is probable.

The samples which had been more heavily irradiated *in vacuo* show a small but significant decrease in Vicat softening point of 0·27° C. for unit fall in $[\eta]$. This would be consistent with a modification of the chain structure, for example, by branching. It could be caused by occluded degradation products, but these would probably be removed during the crystallizing pretreatment for one hour at 140° C. before the softening-point test. It cannot be due merely to a reduction in molecular weight, for a fall in softening point is not detected in samples produced by hydrolysis of normal polyethylene terephthalate until $[\eta]$ falls below about 30.

In agreement with the conclusions from X-ray data[1], these results suggest that the effect of pile radiation, at least up to 800 MW. hr., on polyethylene terephthalate is degradative, although possibly accompanied by branching. Furthermore, the relative ease of solution, unchanged by irradiation, of all the samples in *o*-chlorophenol, together with the lowered softening point are inconsistent with the presence of any measure of cross-linking as reported by Charlesby[2].

Audrey Todd*

Research Department,
'Terylene' Council,
Imperial Chemical Industries, Ltd.,
Black Fan Road,
Welwyn Garden City,
Hertfordshire.

* Present address: Department of Chemistry, Cornell University, Ithaca, New York, U.S.A.

[1] Little, K., *Nature*, **173**, 680 (1954).
[2] Charlesby, A., *Nature*, **171**, 167 (1953).
[3] Huggins, M. L., *J. Amer. Chem. Soc.*, **64**, 2716 (1942).

A Corrected Guldberg Rule

According to the well-known rule of Guldberg[1], the normal boiling point of a liquid is two-thirds of the critical temperature on the absolute scale. The rule is not obeyed by liquids of low boiling point[2], and even for liquids boiling in the range 20–250° C. the ratio T_b/T_c varies from 0·58 to 0·70. Inasmuch as these deviations arise from the different cohesive forces, and the latter are related to the surface tension, we may write

$$T_b\gamma_b^n/T_c = k,$$

where γ_b is the surface tension of the liquid at the boiling point, and n and k are constants. For ordinary organic liquids the relation

$$T_b\gamma_b^{\frac{1}{4}}/T_c = 4/3 \qquad (1)$$

is generally more accurate than the simple Guldberg rule, as may be seen from the following data:

Substance	T_b/T_c	$T_b\gamma_b^{\frac{1}{4}}/T_c$
Carbon disulphide	0·586	1·338
Ethyl bromide	0·618	1·335
Benzene	0·629	1·348
1,1-Dichloroethane	0·633	1·348
Cyclohexane	0·640	1·316
Ethyl ether	0·658	1·305
n-Propyl formate	0·663	1·355
Methyl butyrate	0·677	1·349
*iso*Amyl formate	0·688	1·344
n-Butyl acetate	0·690	1·342
n-Octane	0·700	1·303

A relation between the parachor and the critical volume may be derived from (1). Since the molar volume of a liquid at the boiling point is three-eighths of the critical volume[3], we have

$$\frac{T_b\gamma_b^{\frac{1}{4}}V_b}{T_cV_c} = \frac{1}{2},$$

so that the parachor is given by

$$P = \frac{1}{2}\frac{V_cT_c}{T_b}. \qquad (2)$$

A study of the experimental data led Ferguson and Kennedy[4] to propose the empirical formula

$$P = 0{\cdot}324\ V_c^{\frac{1}{2}}T_c^{\frac{1}{2}},$$

but Lennard-Jones and Corner[5] were able to show, on the basis of dimensional considerations, that the parachor is proportional to $V_c^{\frac{2}{3}}T_c^{\frac{1}{2}}$. For non-associated organic compounds, including those in which the molecules are so unsymmetrical as to restrict rotation in the liquid state, they found that the formula

$$P = 0{\cdot}410\ V_c^{\frac{2}{3}}T_c^{\frac{1}{2}}$$

gave slightly better agreement than that of Ferguson and Kennedy. Examination of the available data for liquids of this type reveals that formula (2) is definitely superior to that of Ferguson and Kennedy, and is in general slightly more accurate than that of Lennard-Jones and Corner.

S. T. Bowden

University College,
Cardiff. July 29.

[1] Guldberg, C. M., *Z. Phys. Chem.*, 5, 374 (1890). Partington, J. R., "An Advanced Treatise on Physical Chemistry", 1, 646 (Longmans, Green and Co., Ltd., London, 1951).
[2] Corner, J., *Trans. Farad. Soc.*, **36**, 784 (1940).
[3] Walden, P., *Z. phys. Chem.*, **66**, 429 (1909).
[4] Ferguson, A., and Kennedy, S. J., *Trans. Farad. Soc.*, **32**, 1474 (1936).
[5] Lennard-Jones, J. E., and Corner, J., *Trans. Farad. Soc.*, **36**, 1156 (1940).

Paramagnetic Resonance, a New Property of Coal-like Materials

Paramagnetic resonance, which has given interesting information on several structures[1], can be used for studying coal-like materials. Using a microwave spectrometer (9,000 Mc./s.) for electronic paramagnetic resonance, we have observed a characteristic line for coals[2]. This sharp line is associated with a Landé factor of 2, which is the free electron value. These results lead us to believe that this paramagnetism is linked with the structure of coal-like materials and cannot be attributed to the minerals always present, such as iron. In the present communication we give further details on the results observed for coals[2] and for several coal-like materials in which paramagnetic resonance has been detected.

The samples of coal studied, coming from mines in northern or eastern France, are of different geological ages. They correspond to the following French designations: anthracite, quart-gras, demi-gras, trois-quart-gras, flambant-gras, flambant-sec. The amplitude of the line decreases from the oldest coal (anthracite) to the youngest one (flambant-sec). Roughly, the amplitude gets smaller as the amount of carbon decreases in the samples and as the amount of volatile substances and oxygen increases. Charring modifies the phenomenon considerably. On heating the coals up to 500° C., the line is seen to decrease gradually with increasing temperature. The line disappears quickly on heating the same samples between 500° and 600° C., when graphitization and electrical conductivity appear. After coking is completed (1,000–1,100° C.) no line can be seen. It must be emphasized that several samples of graphite did not give any line with our apparatus, though a weak line has been reported by Castle[3]. With regard to lignites, the line is absent in a sample from Hostens, present but weak in a sample from Fuveau and in both instances it becomes very strong after heating at 300° C. These results have led us to make some experiments with such materials as charcoals, sugar charcoal and pitches.

Charcoal prepared from pine wood and coconut and also some lightly charred sugars (saccharose, glucose) give a fairly intense paramagnetic resonance line. This line disappears in charcoals activated at 900° C. in presence of combustion gases and steam. No line appears in crude oils; but one is found in pitches which are residues from crude oil distillation. It can be said that paramagnetic resonance appears when carbohydrates are damaged either by Nature, as in coals, or artificially by heating, as in charcoals, sugar charcoal and pitches. The same line appears if the samples (woods, sugars) are irradiated by γ-rays, as was found by two of us[4], which suggests the same sort of damage. This paramagnetic resonance cannot be attributed to a specific defined structure at present; but further experimental and theoretical work is being carried out.

J. Uebersfeld
A. Étienne
J. Combrisson

Ecole Supérieure de Physique et Chimie,
10 rue Vauquelin,
Paris 5. Aug. 2.

[1] Gordy, W., Smith, W. V., and Trambarulo, R. F., "Microwave Spectroscopy", 236 (Wiley and Sons, New York, 1953).
[2] Étienne, A., and Uebersfeld, J., *J. Chim. Phys.* (June 1954).
[3] Castle, *Phys. Rev.*, **92**, 1063 (1953).
[4] Combrisson, J., and Uebersfeld, J., *C. R. Acad. Sci., Paris*, 238, 1397 (1954).

Electroretinal Photopic Sensitivity Curves

Since Adrian[1] first suggested the existence of separate rod- and cone-components in the human electroretinogram, there have been attempts to isolate them so as to demonstrate the degree to which their spectral sensitivity curves adhered to scotopic or photopic patterns.

Thus Riggs, Berry and Wayner[2] determined the function for the *B*-wave. With a 7·5° foveally centred stimulus-flash, the curve closely resembled the scotopic function but was displaced toward the blue. Armington, Johnson and Riggs[3] derived a similar curve for the *A*-wave of the dark-adapted eye. Again excess blue-sensitivity appeared. Boynton[4] has supposed this to be related to the part played by stray light. With small stimulus areas a significant portion of the electrical response is due to light scattered over the peripheral retina, outside the focal area. One contributor is Rayleigh scatter, varying as an inverse function of the fourth power of the wave-length, scattering blue more than red. To support this interpretation, Boynton shows that divergence from scotopic values is less when larger areas are used. Johnson and Armington[5] have confirmed this, demonstrating that with full-retinal stimulation, using an integrating sphere, electrical sensitivity curves for the *B*-wave of the dark-adapted eye coincide with the usual scotopic luminosity curve.

Armington[6] has fitted data for the *X*-wave (Motokawa's designation for Adrian's photopic component) to the CIE photopic luminosity curve. With the photopic receptors we would expect stray light to have less effect. Cones are concentrated near the fovea and are supposed (cf. Stiles–Crawford effect[7]) to be directional. It is disconcerting to find that the *X*-wave curve diverges from the photopic curve just as the small-area *B*-wave curve diverges from the scotopic function. No one has used full-retinal stimulation to elicit the *X*-wave. We cannot say whether such a procedure would bring the *X*-wave

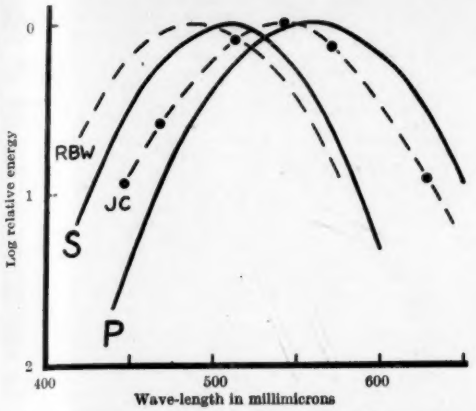


Fig. 1. Log relative energy at each wave-length to achieve standard response. Maxima of curves adjusted to equality. *S*, Scotopic visibility curve; *RBW*, curve for *B*-wave (ref. 2); *P*, photopic luminosity curve; *JC*, curve for *X*-wave obtained by authors using four per sec. flashes in light-adapted eye. Points indicate photopic peaks of narrow-band filters used. Data of three determinations averaged

results into line. Armington speculates that it might not. He has used night-blind subjects and found some alleviation of the disparity. This suggests that the *X*-wave of the normal-seeing person, as elicited by Armington's procedures, is partly of scotopic origin or, alternatively, that the peripheral cones of his night-blind subjects had been affected so that the effect of stray light was diminished even though a 'pure cone' index was being observed.

To throw additional light on the problem we have employed a technique suggested by Dodt[8], in a communication in *Nature* in 1951. He affirms, and we agree, that with a stimulus flickering above a rate of about 20 per sec., scotopic responses appear to fuse, manifesting the equilibrium characteristic of steady illumination. Responses synchronous with 30 per sec. flashes should represent activity of the faster responding photopic system. In the dark-adapted eye there is an initial *B*-wave, following which the 30 per sec. fluctuations appear. These may continue, unaltered, for several minutes. Records taken after different lengths of time in darkness differ only in the size of the initial *B*-wave.

Using 4 per sec. flashes (to which the above argument does not apply), and delivering these to the light-adapted eye, we confirmed Armington's findings for the normal eye. Total height of response was measured, from trough of *A* to peak of *X*. Fig. 1 shows the form of the curve obtained using a 20-μV. response criterion. Excess blue-sensitivity is apparent. (Apparatus and treatment of results in this work were similar to those employed in refs. 2–6.)

With 10-m.sec. flashes delivered to the dark-adapted eye at a rate of 30 per sec., and using a 10-μV. trough-to-peak response criterion, the 'sensitivity curve' (Fig. 2) resembles the photopic more than the scotopic function, but is still displaced slightly toward the blue and is less sharply peaked.

We must either consider the hypothesis that Rayleigh scatter contributes to the photopic electroretinogram, as it does to the scotopic, or we must admit that neither the employment of night-blind subjects nor the use of flickering stimuli prevents intrusion of a blue-sensitive system, presumably the scotopic, which contributes to the electroretinogram yet fails to show itself during determination of the photopic luminosity curve by the standard procedures.

This work was supported by a contract between the U.S. Office of Naval Research and Brown University, and carried out in the Psychology Laboratories of Brown University.

E. P. Johnson
T. N. Cornsweet

Psychology Department,
Brown University,
Providence, R.I.
April 7.

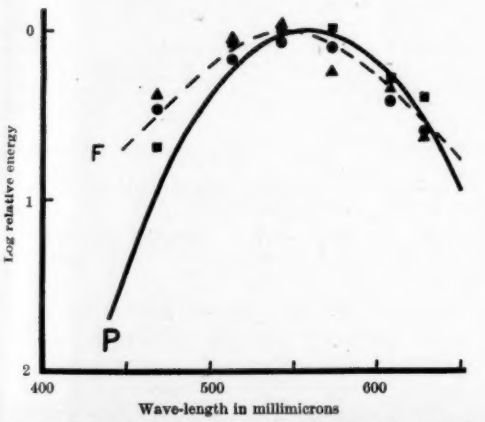


Fig. 2. Log relative energy at each wave-length to achieve standard response. *P*, Photopic luminosity curve; *F*, curve for 30 per sec. flashes. Triangles represent one set of determinations on subject A.T., squares and circles two sets for subject P.J.

[1] Adrian, E. D., *Nature*, **154**, 361 (1944).
[2] Riggs, L. A., Berry, R. N., and Wayner, M., *J. Opt. Soc. Amer.*, **42**, 393 (1951).
[3] Armington, J. C., Johnson, E. P., and Riggs, L. A., *J. Physiol.*, **118**, 289 (1952).
[4] Boynton, R. M., *J. Opt. Soc. Amer.*, **43**, 442 (1953).
[5] Johnson, E. P., and Armington, J. C. (in preparation).
[6] Armington, J. C., *J. Opt. Soc. Amer.*, **43**, 450 (1953).
[7] Stiles, W. S., and Crawford, B. H., *Proc. Roy. Soc.*, B, **112**, 428 (1933).
[8] Dodt, E., *Nature*, **168**, 738 (1951).

A Disease Epidemic in Fish

An epidemic has occurred in a fish culture of *Tilapia mossambica* in Southern Rhodesia during June 1954. The disease had a mortality of more than 90 per cent of the exposed population. *Barbus* species were also affected. Fungus was seen mostly on the extremity of the dorsal fin but frequently occurred on the caudal peduncle, the tail and on the inter-orbital region. Affected fish were seen lying in shallow water and gasping at the surface. The intestine was filled with a clear gelatinous fluid. No macroscopic gill lesions were noticed. Although cold (below 56° F.) seems a predisposing factor, the etiology is not clear. Helminth cercaria may be implicated as well as fungus. Histologically gill necrosis associated with an invasion of conidia-like bodies, and kidney and liver cloudy swellings are present.

Further details will be published later.

H. Affleck

P.B.4, Mazoe,
Southern Rhodesia.
Aug. 30.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Wednesday, September 29

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. A. E. Cutler: "Computing Circuits in Flight Simulators".

Friday, October 1

Hospital Physicists' Association (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. C. A. Coulson, F.R.S.: "Douglas Lea—Physicist into Biologist" (Fourth Douglas Lea Memorial Lecture).*

Saturday, October 2

Royal Photographic Society of Great Britain—Scientific and Technical Group, in conjunction with the University of Durham (in the Lecture Theatre, Stephenson Building, King's College, Newcastle-upon-Tyne), at 10 a.m.—Conference on "Scientific and Technical Applications of Photography".

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists, at the Grand Hotel, Brighton)—Meeting on "Thyroid Function". Morning Session—Papers on "Chemical Pathology"; Afternoon Session—Papers on "Thyroid Function".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Junior Research Fellow (with one or two years postgraduate experience) in Biochemistry, to undertake research in the formation of complexes between metal ions and polypeptides and proteins—The Secretary, The University, Aberdeen (October 1).

Assistant Physicist (with an honours degree in physics and preferably with hospital experience)—House Governor, The London Hospital, Whitechapel, London, E.1 (October 2).

Senior Lecturer or Lecturer (with teaching and research or industrial experience in electronics) in Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (October 4).

Analytical Chemist (with first- or second-class honours degree and preferably with experience in the rubber industry), to supervise analytical work in the chemical division and to carry out research on new methods of physical and chemical analysis in connexion with the natural rubber producing industry; Chemical Engineer (with first- or second-class honours degree and a professional qualification in chemical engineering), to carry out development work to the pilot plant stage, at the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (October 8).

Scientist (with good honours degree in chemistry or physics, preferably with specialization in physical chemistry and experience of surface chemistry), at the Coal Survey Laboratory, Leeds—National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/841 (October 9).

Lecturer, Grade A, in Botany, and a Lecturer, Grade A or B, in General Science, at the Kumasi College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 11).

Keeper (with experience in archives administration) in the Department of Archives—The Director, Museums and Art Gallery, New Walk, Leicester (October 12).

Lecturer (graduate in electrical engineering and preferably with experience in electrical measurements, transmission and distribution of electricity, or high frequency line communication) in Electrical Engineering, at the Auckland University College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Lecturer in Machine Tools and Metrology in the Department of Engineering Production, to be responsible for the Metrology and Machine Tool Research Laboratories and for postgraduate teaching and research—The Secretary, The University, Birmingham 15 (October 15).

Research Officer (graduate, preferably with honours degree in veterinary or agricultural science with specialization in animal genetics, and with experience in wool technology and statistical methods and knowledge of the sheep and wool industry) in the Trangie Experiment Station, New South Wales Department of Agriculture, to be responsible to the Director of Veterinary Research for organizing and supervising research projects of the Wool Research Laboratory—The Agent General for New South Wales, 56/57 Strand, London, W.C.2 (October 18).

Senior Lecturer (preferably with good knowledge of classical theoretical physics and quantum theory) in Physics, at the University of New England, Armidale, New South Wales—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 18).

Senior Lecturer in Agricultural Economy; Lecturer in Soil Science; Lecturer in Animal Production at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 22).

Chair of Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (October 25).

Lecturer in Agricultural Economics and Farm Management at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

Senior Lecturer in Statistics at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 29).

Assistant Lecturer (with special qualifications in applied mathematics) in Mathematics—The Registrar, The University, Manchester 13 (October 30).

Senior Horticulturist, Senior Scientific Officer grade (with honours degree in botany and with research experience) in the Pomology Section, for work on fruit tree rootstocks—The Secretary, East Malling Research Station, Maidstone, Kent (October 30).

Chair of Applied Mathematics at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Chair of Animal Husbandry at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 6).

Electronic Engineer or Physicist to assist in installation and operation of electronic digital calculator—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

Lecturer (with a degree in mechanical engineering and teaching experience, and preferably with industrial experience) in the Department of Engineering—The Principal, County Technical College, Gainsborough.

Lecturer (with an honours degree and preferably with industrial experience) in Physics—The Principal, Paisley Technical College, Paisley.

Principal or Senior Scientific Officer (with first- or second-class honours degree in civil engineering, or equivalent qualification, with experience in the planning and construction of roads or similar civil engineering work, and preferably with experience of economic problems) at the Road Research Laboratory, Harmondsworth, to study the economics of road construction and maintenance—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E591/54/A.

Research Demonstrator in Physics—The Registrar, University College, Leicester.

Research Engineer (with a university degree and some workshop experience, and preferably with training in research), for experimental work into the stresses in steam pipe-work with particular reference to advanced steam conditions—Prof. H. Ford, Mechanical Engineering Department, Imperial College, London, S.W.7.

Rubber Technologists or Science Graduates (interested in the practical applications of science) to undertake technological investigations—The Secretary, Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Salop.

Senior Materials Engineer (with university degree in science and qualified for membership of the Institution of Civil Engineers and with at least 10 years postgraduate experience on road or airport construction including theoretical and practical experience of applied soil mechanics and analysis) in the Public Works Department, Gold Coast Government, to be responsible for the Materials Section, Public Works Department Road and Bridges Branch, including all its field and laboratory activities—Adviser on Recruitment, Gold Coast Office, Melbourne House, Aldwych, London, W.C.2.

Senior Scientific Officer (with first- or second-class honours degree in physics or physical chemistry, or equivalent qualifications, and with several years postgraduate research experience) to lead a group investigating the application of engineering technology to the manufacture of explosive weapons, including the study of dust explosion and static hazards—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 107/WGE/54.

Senior Scientific Officer (Ref. 659) (with first- or second-class honours degree in chemistry, or equivalent qualification, and with at least three years postgraduate experience of inorganic analysis) to take charge of group engaged on research and development work in inorganic analytical chemistry, including the application of modern analytical techniques; Senior Experimental Officers (Ref. 660) (with H.S.C. Science and experience in analytical chemistry) to supervise laboratories engaged on analysis of materials used in atomic energy processes; Assistant Experimental Officers (Ref. 661) (with H.S.C. Science and experience of chemical analysis, preferably in the organic field) for analytical work on materials used in atomic energy processes, with the United Kingdom Atomic Energy Authority, Capenhurst—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting appropriate reference.

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office